Vol. 12 MARCH • 1949 No. 1

# LLOYDIA

*A Quarterly Journal of Biological Science*

Published by the Lloyd Library and Museum, Cincinnati, Ohio

## A Revision of Ryania (Flacourtiaceae)[1]

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### INTRODUCTION

Ryania, named by Vahl in honor of John Ryan, "Medicinae Doctori, historiae naturalis cultori perstudiosissimo," was conserved in 1905 by the International Botanical Congress at Vienna in favor of Patrisia L. C. Richard. The genus comprises eight species, nine varieties, and a vast number of forms, widely and abundantly distributed in tropical South America. It is notable for its very toxic properties.

Casual examination of the group in 1942 quickly convinced the author that taxonomically the species were in dire confusion. For some characters generally considered of generic importance broke down hopelessly in the attempt to delimit species of Ryania, while others were hardly more useful. Specimens otherwise nearly identical had both small flowers approaching in size certain members of Casearia and larger showy flowers, with sepals and anthers approximately four times as long; without being correlated with other characters, they had very short and long filiform styles (now known to be the result of heterostyly), either entire or conspicuously cleft at the apex, the 3 to 9 branches terminating in as many stigmatic points. Upon dissection the one-celled ovary was found to have 3 to 9 parietal placentae, and in one anomalous instance a manifest central column projecting from the base was observed. Some specimens had a gynophore reminiscent of Passiflora and a high corona-like disk, while others lacked a stipe and had a very short disk, without showing other noticeable differences. Numerous striking variants in trivial characters were found, including specimens with leaves of variable outline, entire or obviously serrate, with the indumentum ferruginous or cinereous and with hairs ranging in size from microscopic to two mm. long, closely appressed to erect, the stellae 2-18-rayed. They seemed to transgress all reasonable bounds. Despite such startling differences, all entities appeared to be related as members of a single large species-complex embracing numerous forms.

The available literature offered no help. A recent collector reported that a good set of his plants now definitely known to represent two

[1]These studies were supported in part by Merck & Co., Inc.

species (*R. speciosa* var. *tomentosa* and *R. pyrifera*) was obtained practically on the same hillside in Surinam and that in the field the plants had the appearance of a single entity without indication of incidental variation. The discriminating observer, Sagot, after extensive collecting in French Guiana, refused to recognize as distinct from *R. speciosa* a species named in his honor by Eichler, *R. Sagotiana* (=*R. pyrifera*). But the impressions of field men did not prevent herbarium botanists from describing novelties. About twenty-five years ago, T. A. Sprague and L. A. M. Riley, in preparing a revision (unpublished) of the Kew material of Ryania, designated nine specimens as types of new species. Since that time, however, botanists have shied away from studying the group; nevertheless, one new species (1934; rejected) and two new varieties (1943 and 1945; accepted) have been described.

Recently, material of Ryania from many institutions and the types of critical species were made available to the author for study. The result is the following taxonomic treatment.

The baffling tangle of forms was resolved into orderly series and certain fairly coherent species were distinguished. Apparently *R. speciosa* comprised an assemblage of weak varieties distributed almost throughout the entire range of the genus. The type of *R. pyrifera*, received on loan from Paris, rectified in a ludicrously simple manner a misconception that was held almost universally since 1806. *R. pyrifera* is synonymous with *R. Sagotiana*, but not at all with *R. speciosa*.

This example emphasizes the importance of types. It is true that when I first considered, from circumstantial evidence, the problem of the real identity of *R. pyrifera*, I saw no reason for accepting its synonymy with *R. speciosa* and actually suspected its true affinity. Nothing in the original description of Richard excluded *R. Sagotiana*. The species was collected in French Guiana where *R. Sagotiana* is common, and the specific epithet "*pyrifera*" suggested some stipitate condition of the fruit—an important character for distinguishing *R. Sagotiana*. However, conjectures and doubts would have remained, and it would have been impossible to ascertain the distinctness of *R. pyrifera* from some varieties of *R. speciosa*, such as var. *subuliflora*, without consultation of the type.

Nomenclaturally, the discovery of the true identity of *R. pyrifera* necessitated new combinations (*R. speciosa* var. *subuliflora* and *R. s.* var. *tomentosa*) for two varieties already published and, since the majority of Ryania material collected belongs to *R. speciosa* and its varieties, considerable renaming of herbarium specimens. The transfer to varietal status of three species (*R. speciosa* var. *stipularis*, *R. s.* var. *chocoensis*, *R. s.* var. *bicolor*), the description of three additional varieties (*R. speciosa* var. *minor*, *R. s.* var. *panamensis*, *R. s.* var. *Mutisii*) and a new species (*R. Spruceana*), culminated by the unearthing of a prior specific epithet for *R. acuminata* (*Tetracocyne angustifolia*), has altered almost entirely the nomenclature of Ryania.

Much still remains to be done in the study of Ryania. The precise conditions explaining its amazing polymorphism need clarification. Cultivation, particularly of the varieties of *R. speciosa*, with meticulous observation of the stability of characters under controlled conditions is

prerequisite to exhaustive taxonomic investigations of the group. Following similar methods and breeding for high toxicity should bear excellent results in its use as an insecticide. Genetic studies are emphatically recommended.

*Literature.*—The only noteworthy taxonomic treatment of Ryania hitherto published is that of Eichler (24) in Martius' *Flora Brasiliensis.* This excellent work after seventy-seven years still covers most of the essential features of the group. The generic description is comprehensive and elaborately illustrated, three species being figured, leafy branches with flowers and flower analyses of *R. canescens* and *R. Riedeliana*, and fruit, seed and embryo of *R. Mansoana.* These species, as well as *R. acuminata* (=*R. angustifolia*) and *R. dentata*, are amply described. An adequate characterization is rendered of *R. Sagotiana* (=*R. pyrifera*). *R. speciosa* is interpreted to include the varieties from French Guiana, Surinam (?), Amazonas in Brazil, Venezuela, and Colombia (?), besides the typical element from Trinidad. *R. chocoensis* is discussed briefly and *R. bicolor* is noted in observation (these two being merely varieties of *R. speciosa*). The taxonomic characters adduced by Eichler for delimiting the species are those chiefly employed in the present study, hardly any additional ones of great importance having been discovered.

Nomenclaturally, Eichler's treatment of *R. speciosa* is more timely than those of his successors, most nearly approaching the present one. He erred a little by being overconservative in not recognizing diverse elements in this complex species, but he avoided the confounding tendency seen in others of describing new species *ad infinitum.* The varieties of *R. speciosa* are indeed very weak and the species might, with some justification, be considered as a single variable unit embracing various populations.

Following many of his predecessors, Eichler erroneously placed *R. pyrifera* in synonymy under *R. speciosa.* Like others before and since, he misinterpreted *R. parviflora.* (The type of *R. parviflora* is merely a form of *R. speciosa* var. *tomentosa*, whereas Eichler's concept is that of *R. s.* var. *minor.*) *R. tomentosa* he placed questionably in the synonymy of *R. speciosa.* Under *R. Sagotiana* he cited *Sagot 57* and *Spruce 3773.* The former is identical with *R. pyrifera;* the latter typifies a new species, *R. Spruceana.*

Other taxonomic studies of the group are of local interest, not comparable to that of Eichler. Triana and Planchon (57) and Bentham (4), in discussing the position of Ryania, recognized its divergence from the Passifloraceae. The former botanists admitted its affinity to that family as well. They observed the perigynous insertion of the stamens. They noted what is now all too obvious, that all the species resemble each other in foliage and inflorescence. The fact of extensive variation in the group was emphasized by Sagot (52), who wrote that he observed "*R. speciosa*" frequently in French Guiana and that it varied in having styles very long or short, stigmas tuberculate or rarely on short branches, stamens long or a little shorter, pedicels very short or conspicuously elongated, disk high or very low or possibly none, and ovary subsessile or stipitate. However, his observations on the gynophore, nectary and

pedicels were probably the result of his confusing *R. pyrifera* with *R. speciosa.* Particularly noteworthy is the indication that Sagot observed heterostyly, and his suspicion that male or female sexes predominated in different plants.' A. Richard (49) declared that the alleged distinctions between Ryania and Patrisia hardly had any real basis.

Recently Sleumer and Uittien (55) treated the two species found in Surinam. In reducing to varietal status Miquel's *R. tomentosa,* they set an example for the proper evaluation of trivial characters. Sandwith (53), displaying his customary good insight, likewise published as a variety a plant designated as a new species by Sprague and Riley. With the exception of the epithet "*subuliflora,*" adopted by Sandwith for a new variety, and a name which somehow found its way on a sheet of *R. pyrifera* deposited at the herbarium of the British Guiana Botanical Garden, the names proposed by Sprague and Riley have found no acceptance whatsoever and, in the material examined, appear solely on the Kew herbarium sheets. The manuscript of Sprague and Riley's revision is preserved at Kew.

Illustrations are of prime importance in descriptive botany and, as already indicted, those contained in *Flora Brasiliensis* copiously delineate the genus. The original figures of *R. speciosa* presented by Vahl (58) are also excellent, and so are those of *Patrisia parviflora* (=*R. speciosa* var. *tomentosa*) by Delessert (15). The ovule was discussed and illustrated by Reissek (48). The wood structure was closely investigated by Bannan (2). It was also studied by Nakarai and Sano (40) and given brief notice by Record (46; 47). Harms (26) touched upon the wood and leaf anotomy, and his findings are recorded by Solereder (56).

The toxic principle of Ryania has been more or less under investigation for over half a century. In 1897 Cortés (12) referred to the discovery by Prof. D. Carlos Balén of a very toxic alkaloid in a Colombian species called "Matacucarachas." Since 1930 studies in the chemical and physiological properties of Ryania have increased. *R. angustifolia* was studied by Le Cointe (36), Bret (8), Merz (38), and Nakarai and Sano (40); *R. dentata* var. *toxica,* by Mezey (39). R. Quintero Serra's thesis, presented in 1930 to the Central University of Venezuela, treated the chemistry of extracts from *R. speciosa* var. *stipularis.* In 1948, several very significant papers appeared under this heading. Rogers *et al.* (51) reported that ryanodine, tentatively formulated as $C_{25}H_{35}$ $NO_9$ or $C_{26}H_{31}$ $NO_9$ and appearing to be the first characterized flacourtiaceous alkaloid, was isolated from root and stem material of *Ryania speciosa.* Hassett (27) studied the effect of ryanodine on the oxygen consumption of the roach. In August, Kuna and Heal (35) published important information concerning the results of toxicological and pharmacological studies on the effect of the powered stem of *Ryania speciosa* in various animal species together with comparisons with other known insecticides. In September, Edwards *et al.* (23) reported that a highly selective mode of action in ryanodine which appears to affect specifically the contractile process in striated muscle is indicated by preliminary observations on derivatives of *R. speciosa.*

Literature on the use of Ryania as an insecticide dates from 1945. The paper by Pepper and Carruth (42), first to appear, is the most extensive. Mention of Ryania, or its insecticidal product, Ryanex, is made by Wheeler (61) in 1945; Bishopp (6), Dills (16), Huckett (29), and Wheeler and La Plante Jr. (62) in 1946; and many authors in 1947 (5, 7, 10, 11, 13, 14, 28, 30, 31, 44, 45, 63) and 1948 (17, 18, 19, 20, 21, 33, 34, 41, 50, 54).

*Uses.*—Ryania is extremely toxic, acting as a violent stomach poison on both warm and cold blooded animals. All parts of the plant—roots, stems, bark, and leaves—are to a greater or lesser extent deadly. Probably all the species and varieties are poisonous. (The toxicology of the relatively highly distinctive *R. canescens* or *R. Mansoana* is not known.) Definite reports are available for *R. angustifolia*, *R. dentata*, and var. *toxica*, *R. pyrifera*, *R. speciosa*, and vars. *bicolor*, *stipularis*, *tomentosa*, and *R. Spruceana*. The Indians of the Amazon have used *R. angustifolia* to poison alligators. Bonpland in 1821 reported the roots of *Patrisia affinis* (=*R. dentata*) as "valde venenosa." In 1897 Cortés (12) wrote that a species of Ryania called "Matacucarachas" in the valley of the upper Magdalena River in Colombia was very poisonous with a physiological effect resembling that of strychnine. He thought the active principle to be an alkaloid and named it "ryanina"; the unique smell alone of this, he added, was sufficient to produce a constriction of the neck muscles, even causing respiratory paralysis; a single drop of its ethereal solution proved lethal to some animals. Nakarai and Sano (40) tested *R. angustifolia* on the mouse, rabbit, cat, dog, and fish. Mezey (39) reported the isolation of a glucoside from the leaves of *R. dentata* var. *toxica* and described the toxicity of "ryanina" on the rabbit.

In reference to the toxic character of Ryania an important distinction should be made. A memorandum from Merck & Co., Inc., informs the present author that: "The concentrated alkaloid is highly toxic, and its potency as reported in the literature was confirmed in the first tests conducted in the Merck Institute. A distinction has been made here, however, and should be recognized, between the toxicity of the concentrated active principle and the toxicity of the insecticidal preparations. The latter possess low toxicity to warm-blooded animals in comparison with other commonly used insecticides." For a published report substantiating this statement see Kuna and Heal (35).

The active principle of Ryania is an effective insecticide. Exploratory field tests with derivatives of Ryania as an insecticide were begun in 1943. Ryanex, prepared from *R. speciosa*, has been put on the market by Merck & Co., Inc., (patent Folkers *et al.* U. S. 2400295) and an announcement of this product appeared on p. 13 of the Florists Exchange and Horticultural Trade World for Jan. 6, 1945. It is said to be as good and possibly better than DDT against the European Corn Borer, promising against the Sugarcane Borer and the Oriental Fruit Moth, and an effective control of the Soybean Caterpillar.

*Local names.*—*Aquacer* or *Aquacero* (*R. speciosa stipularis*, Venezuela: Sucre), *Bois l'Agli* (*R. speciosa*, Trinidad), *Borrachero* (*R. dentata toxica*, Colombia: Boyacá), *Canabeby* (*R. angustifolia*, Brazil, Mundur-

ucús Indians), *Capansa* (Brazil: Acre), *Ciezo* (*R. speciosa stipularis*, Venezuela: El Lemón; Aquacatal), *Coatí-Caá* (*R. speciosa minor*, Brazil: Rio Vaupes near Panure), *Guachamaca* or *Quachamaca del Negro* (*R. speciosa stipularis*, Venezuela), *Guaricamá* or *Guaríkma* (*R. Spruceana*, Venezuela: Amazonas, Rio Guainía), *Guaricamo* (*R. dentata*, Venezuela: Orinoco), *Kibidan* (Surinam, Arawak Indians), *Kibihidan* (*R. speciosa subuliflora*, British Guiana: Mazaruni Rv.), *Koolioniree* (*R. pyrifera*, British Guiana: upper Demerara Rv.), *Mata Cachorro* (*R. angustifolia*, Brazil: Amazonas), *Mata Calado* (*R. angustifolia*, Brazil: Tapajoz Rv.), *Matacucarachas* (*R. speciosa tomentosa*?, Colombia: upper Magdalena Rv.), *Mucuracaá* (*R. speciosa subuliflora*, Brazil: Rio Negro, Tarumansinho), *Tomoipjo* (Surinam, Carib Indians), *Uairú Mirá* or *Uauirú Mirá* (*R. speciosa bicolor*, Brazil: Rio Negro, Icana Rv. *R. speciosa minor*, Brazil: Rio Negro, Macubeta; Rio Vaupes).

*Abbreviation of herbaria and acknowledgments.*—The herbaria in which the specimens examined are deposited are abbreviated as follows: A—Arnold Arboretum, Jamaica Plain; Brx—Jardin Botanique de l'Etat, Brussels: F—Field Museum of Natural History, Chicago; G—Conservatoire et Jardin Botanique, Geneva; GH—Gray Herbarium, Harvard University, Cambridge; K—Royal Botanic Gardens, Kew; M—Missouri Botanical Garden, St. Louis; Mich—University of Michigan, Ann Arbor; NY—New York Botanical Garden, New York; P—Museum d'Histoire Naturelle, Paris; Ph—Academy of Natural Sciences, Philadelphia; S—Naturhistoriska Riksmuseet, Stockholm; U—Botanisch Museum en Herbarium, Utrecht; US—United States National Herbarium, Washington; Y—Yale School of Forestry, New Haven. Acknowledgment is here made to the directors and curators of the institutions listed for their generous loans of herbarium material, and my particular gratitude is expressed for the aid rendered me by Mr. B. A. Krukoff, Dr. H. A. Gleason, and Dr. H. N. Moldenke.

## SYSTEMATIC TREATMENT

RYANIA Vahl, Eclog. Am. **1**: 51. t. 9. 1796. (*nom. conserv.*)

*Patrisia* L. C. Richard, in Act. Soc. Hist. Nat. Par. **1**: 110. 1792. (*nom. rejic.*) A. DC., Prodr. **1**: 255. 1824. (homonym.) Non Rhor ex Steud., Nom. Bot., ed. 2, **1**: 342. 1840. (as synonym of *Chailletia* DC.).
*Ryanaea* A. DC., Prodr. **1**: 255. 1824.
*Tetracocyne* Turcz., in Bull. Soc. Nat. Mosc. **36**(2): 555. 1863. (as synonym of *Ryania* Vahl.). Appendix Prim. ad Prim. Pt. Cat. Plant. Herb. Univ. Charc. 1857. (fide Turcz.).

Small slender stellate-pubescent poisonous trees or shrubs, 1 (or less)–15 m. tall; stem usually simple, up to 20 cm. diam., wood hard; branches very slender, terete or somewhat ridged, canescent or densely tomentose to glabrescent; pith pale brown, circular. Indumentum of 2–18–rayed stellae, rarely of simple hairs, the rays issuing from a minute tubercle and varying in size from microscopic to 2 mm. long, closely appressed to erect, terete, sharp-pointed, mostly straight, apparently 1–celled, easily dislodged. Leaves alternate, distichous, epunctate, canescent or densely tomentose to glabrescent. Stipules 2, deciduous, acicular to narrowly lanceolate, 2–25 mm. long, up to 1 mm. broad,

glandular near base within. Petioles short, 2–6 mm. long, terete, rounded beneath, channeled above. Blades involute in vernation, at maturity chartaceous or membranaceous to coriaceous (0.1–0.5 mm. thick intercostally), lanceolate or ovate to elliptic or oblong, 5–28 cm. long, 2.5–9 cm. broad, rounded to tapering at base, equilateral or subasymmetrical, usually acuminate or caudate at apex and finely pointed, sometimes rounded and merely mucronate; acumen 1.5–4 cm. long, occasionally falcate; margins of blade entire or irregularly denticulate-serrate, or merely glandular-thickened at termination of veinlets; under side glabrous to white-canescent or ferruginous-tomentose; upper side dull or shining, glabrous to sparsely pubescent; midrib often hirtellous, raised or somewhat depressed, raised below; lateral nerves pinnately arranged, parallel, alternate, 5–13 pairs, without fainter nerves in between, ascending, arcuate, becoming faint near leaf-margins, raised beneath, raised or slightly depressed above; reticulation intricate, prominulose, the veins sharp and the ultimate veinlets very fine, often irregularly minutely tuberculate; mesophyll traversed by spicular cells.

Inflorescence axillary, few-flowered; rachis very short, 2–8 mm. long; flowers 1–4, monochlamydeous, hermaphrodite but heterostylous, often showy, white or yellowish and pink or red, fragrant. Pedicels very short or up to 3 cm. long, terete, more or less fluted, slightly widening toward apex, stellate-tomentose, articulate at base or up to 1.2 cm. from base, bracteolate at base; bracts deciduous, deltoid, short, about 3 mm. long and 2 mm. broad, or smaller, sparsely and faintly glandular-denticulate. Calyx-tube very short, about 2 mm. or less long. Sepals quincuncial, 5, nearly free, persistent or deciduous, petaloid, narrowly lanceolate to broadly oblong-elliptic, 1–5 cm. long, 2–12 mm. broad, subequal in length but varying in width in the same flower, acute or obtuse at apex, densely stellate-tomentose on both sides, rather thick, showing veins by transmitted light, spreading at maturity, erect after anthesis. Stamens inserted in 2–3 series at summit of calyx-tube near base of sepals, numerous, 30–70, free or nearly so, crowded, erect, subequal. Filaments filiform-subulate, subequal in length (the outer longer in bud), 0.8–2.5 cm. long, about 0.5 mm. broad, flat, tapering to a fine point at apex, glabrous or sparsely pilose particularly at base. Anthers attached near base, oblong to linear, 2.5–9 mm. long, about 0.5 mm. broad, lightly sagittate at base, sometimes minutely mucronate, often manifestly mucronate at apex (mucro up to 0.5 mm. long), glabrous or sometimes sparsely pilose on the connective, 4-celled, introrse, opening by two full-length longitudinal slits, showing the membranaceous partition in between after dehiscence, the valves thin, becoming wavy-margined after pollen is shed. Pollen (dry) ellipsoid-fusiform, about 45$\mu$ long, 23$\mu$ broad, smooth, with a single longitudinal furrow. Disk immediately next to stamens on axial side, coroniform, urceolate, villose outside, glabrous within, sharply inflexed at ½–¾ of its length, 1–5 mm. high to the fold, which is barbate-villose and with a sharp keel deeply unequally toothed (teeth up to 1 mm. long). Ovary superior, sessile to manifestly stipitate (stipe up to 5 mm. long), subspherical-ellipsoid, densely stellate-tomentose and hirsute, unilocular, with 3–9 parietal placentas. Ovules numerous, in many ranks, minute (0.2–0.3

mm. long), anatropous, the funicle distinct, about equal to length of ovule. Style terminal, 0.3 cm. (short-styled)–3 cm. long, pilose at base, glabrous or pilose above, entire to apex or 3–9-fid, these style-branches up to 3 mm. long, sometimes of irregular lengths in same flower, variable in number in same species. Stigmas capitellate, at apices of style-branches, reaching anthers or far above or below them.

Fruit an unilocular capsule,[2] spheroid to pyriform, lightly lobulate, 1–6 cm. long, suberose or with spongeous emergences, stellate-tomentose and more or less hirsute, the base of style often persistent as an apiculus; exocarp up to 8 mm. thick; endocarp crustaceous or osseous, 0.3–6 mm. thick, sometimes sculptured outside, stellate pubescent within or interplacental areas. Seeds numerous (average 25–150 per fruit), attached to low placental ridges, spheroid to bluntly angulate, 3–5 mm. diam., hispidulous with scattered stellate hairs; outer coat membranaceous, brown, microscopically reticulate or pitted; inner integument crustaceous, about 0.1 mm. thick, with very fine parallel striae which are somewhat branched and sometimes cross-connected; endosperm abundant. Aril at base of seed membranaceous, brown resinous-punctate. Embryo erect; radicle about 1 mm. long; cotyledons flat, thin, ovate, about 1.75 mm. long, 1.2 mm. broad, rounded at base, blunt at apex, without manifest nerves but lined under high magnification.

*Type species.*—*Ryania speciosa* Vahl.

*Distribution.*—From Trinidad, Venezuela, and Panama south, embracing the whole of tropical South America, centering in the Amazon Valley, and reaching down into Matto Grosso (Cuyabá) in Brazil. The southern limit, as now known, are the states of Pará, Matto Grosso, and Amazonas in Brazil, Loreto and San Martín in Peru.

Patrisia L. C. Rich., the earlier name, was adequately described, and its type species (*P. pyrifera*) consisting of excellent material including both flowers and fruits is preserved at Paris. Although omitted by Willdenow in Linné's Sp. Pl., the name has been amply represented in literature for over 140 years; it was afforded equal rank with Ryania by De Candolle in Prodromus, by Roemer in Synopsis, by Sprengel, by Meisner, and others who thought the two genera were distinct from each other, and it was given preference by H.B.K. in Nova Genera, by Warburg in Pflanzenfamilien, and by some others who recognized the synonymy. All the species, except *R. speciosa*, were transferred to Patrisia by Kuntze in 1891. Except for the fact that Ryania was better characterized in the original publication, principally by the elaborate illustration, and that consequently it has enjoyed a wider acceptance, its conservation is rather arbitrary.

Patrisia A. DC. is typified by *P. parviflora*. The genus was distinguished by De Candolle from Ryania by its capsular dehiscent fruit and lack of urceolus. Four species were cited, the first two of which were collected by Patris: *P. bicolor*, *P. parviflora*, *P. dentata* H.B.K., and *P. affinis* H.B.K. However, the third species listed was originally described as having a "discus inter stamina et ovarium," and *P. affinis*

[2]Some fruits are valvately dehiscent. It is not clear whether those with thick osseous endocarps are so.

is a synonym of it. *P. bicolor* was without fruit. The second species cited had immature flowers, which accounts for the oversight of its disk; it included fruits, and its description was amplified in Delessert. Contrary to the modern practice of interpreting names by the type method, De Candolle, while excluding the type species of Patrisia Richard (which he placed in the synonymy of the later *R. speciosa*), upheld and distinguished the genus itself, giving it a personal circumscription. The Patrisia of De Candolle, interpreted as a name based on a different type from the Patrisia of Richard, is therefore a later homonym. De Candolle cited the genus as "Patrisia H.B. et K. nov. gen. 5. p. 356." This is a wrong accreditation, for the authors of Nova Genera merely accepted Richard's genus and placed Vahl's Ryania in straight synonymy. The style of citation in Prodromus signifies that Patrisia, as circumscribed by H.B.K., not as originally characterized by Richard, was accepted by De Candolle.

Ryanaea was proposed by De Candolle to avoid confusion with Riana.

Tetracocyne is placed in synonymy on the authority of the author himself. Turczaninow wrote: "genus meum in app. 1 ad prim. part. cat. pl. herb. Univ. Charc. Charkoviae 1857 descriptum, sine dubio cum Ryania Vahl, ad Passifloreas perperam relata, identicum est." The full title of the reference quoted, as it appears in the Bradley Bibliography, is: "Appendix prima ad primam partem catalogi plantarum herbarii Universitatis caesareae charcoviensis. 18 pp. Q. Charcoviae, 1857." This paper is not at the Arnold Arboretum, and it was not located in the Union Catalog. Sandwith reported that it is not at Kew and is not mentioned in the British Museum Catalog; Hultén failed to find it in any of the Swedish botanical libraries; Baehni likewise could not locate it at Geneva, nor Tardieu at Paris.

The genus Ryania is without close relative. Even in a sterile condition it can be distinguished, but not too easily, from species of other genera, such as Hydnocarpus and Casearia, which resemble Ryania superficially. Its position near to Casearia, as suggested by Eichler and Warburg, is satisfactory. Comparison with a species such as *Casearia Spruceana* Benth. will demonstrate this. While differences are obvious, note the many similarities, the serial-appositional arrangement of sepals, the stamens and disk-appendages or staminodes, the membranaceous aril, and numerous other technical details, as well as the striking general resemblance in habit.

In 1822, R. Brown (9) suggested that Ryania shows a transition from Smeathmannia. Endlicher, in Gen. Pl., placed the genus, together with Smeathmannia Sol. and Paropsia Noronh., in the "tribe Paropsieae, ordo Passifloreae." The early location of Ryania in the Passifloraceae was not altogether unreasonable. There are real ties to that family. Another remarkable flacourtiaceous genus, the monotypic Ancistrothyrsus Harms, a liana with stipitate ovary and extrastamineal corona, is additional evidence of close ties between some representatives of the Flacourtiaceae and the Passifloraceae. Hutchinson (Fam. Fl. Pl. **1**: 162. 1926) places Ryania in the Samydaceae.

De Candolle erected the tribe Patrisieae to embrace exclusively

Ryania (and Patrisia), whereas Baillon (1) distinguished the "sous-série des Ryaniées." Is the genus sufficiently distinct from all other Flacourtiaceae to merit its typifying a tribe? Yes, if considered purely from the morphological point of view; but the tribe would be monotypic. Ancistrothyrsus and other flacourtiaceous genera could be treated likewise. The family Flacourtiaceae is notorious for being a medley of many loosely coherent or heterogeneous groups sometimes represented by only one or several species.

In the treatment following the key, the serial arrangement of the varieties of *R. speciosa* reflects merely their geographic distribution, for they are all closely allied taxonomically. An exception is made of var. *bicolor*, because of its striking appearance. *R. dentata* (and var. *toxica*) and *R. angustifolia* are a close taxonomic unit. *R. Riedeliana* is most closely allied to, but stands somewhat removed from, another pair of connaturals, *R. pyrifera* and *R. Spruceana*. Occupying the southernmost range of the genus, *R. canescens* and *R. Mansoana* display a most intimate kinship.

*Variation.*—Bannan (2) wrote concerning the wood structure of Ryania: "The range of variability in one species extends deep into that of the most similar species. Slight specific differences are indicated, but as a rule the differences are too small and the variability too great for any of these characters, taken alone, to have diagnostic value in distinguishing species." This is painfully true also for the usual taxonomic characters. The species display an amazing and baffling degree of variation in all features, without concomitancy. Outline and size of leaves are mostly without significance, and the density or character of indumentum is of trivial importance. In some species or varieties the stipules may vary in length 4– or 5–fold, pedicels and sepals 3-fold, anthers 2–fold. The anthers may be conspicuously mucronate at the apex or only slightly so; sepals twice as broad in the same flower; pedicels disarticulating 3–12 mm. from the base; upper side of the leaf may have a conspicuous line of hairs along the midrib or be completely glabrous, the margins dentate or entire. Because of heterostyly, the length of the style is unreliable; the number of clefts at the apex of the style is indicative of the number of placentae, neither being important, whereas their depth is unserviceable for taxonomic purpose.

Note should be made of the state of maturity in interpreting characters, since the pedicel, stipe, and disk, as well as the sepals, develop with age. Experience with the dynamics of growth-habit, of age-development relationship, is very helpful in identifying material, but too intangible to express in a practical key and descriptions. Flowers are usually necessary in determining species, and when inadequate result in uncertainty.

There are no empirical data on hybridization in Ryania, but it seems likely that hybrids can occur with facility. It might be hypothesized, without good grounds for either supporting or contesting it, that the flagrant variability displayed by them simultaneously with basic intimate kinship is the result of frequent indiscriminate hybridization amongst the descendents of two or several prototypes.

## KEY TO THE SPECIES AND VARIETIES OF RYANIA

(Characters difficult to define and variable; entities separated by concurrence of features.)

1. Leaf-blades beneath glabrous to rusty-tomentose but not canescent (except *R. speciosa* var. *bicolor*, with hairs less than 0.16 mm. long); reticulation very close and fine; inflorescences 1- or 2-flowered; pedicel disarticulating at base.........2.

 2. Ovary sessile or nearly so; disk short; sepals persistent; endocarp of mature fruit crustaceous.........3.

  3. Pedicels 3–10 (–15) mm. long. (Varieties of *R. speciosa*, greatly intergrading).........3a.

   3a. Leaves concolor, not white-canescent beneath; pubescence rusty colored.........3b.

    3b. Branchlets and leaves not softly tomentose.........3c.

     3c. Pedicels 3–7 (–11) cm. long.........3d.

      3d. Young branchlets not rusty-spotted; stipules short and caducous.........3e.

       3e. Sepals 20–40 mm. long, 4–12 mm. broad, anthers 5–7 mm. long; leaves with pubescence sparse, appressed, reticulation on upper side not prominent (Trinidad), 1. *R. speciosa* (typical).

       3e. Sepals 13–30 mm. long, 3–7 mm. broad......3f

        3f. Anthers 5–7 mm. long; sepals 18–30 mm. long, 3–6 (–7) mm. broad (Guianas, Brazil)..............1a. var. *subuliflora*.

        3f. Anthers 2.5–5 mm. long; sepals 12–18 mm. long, 2–6 mm. broad............3g.

         3g. Reticulation on upper side of leaves prominent; sepals 2–4 mm. broad (Guianas to Peru)....1b. var. *minor*.

         3g. Reticulation on upper side of leaves not prominent; sepals 4–6 mm. broad (Panama)......1e. var. *panamensis*.

      3d. Young branchlets spotted by aggregation of rusty tomentum; stipules mostly long (6–25 mm.) and relatively persistent; reticulation prominent; sepals 18–33 mm. long, 8–13 mm. broad; anthers 5–6 mm. long (Northern Venezuela).......1d. var. *stipularis*.

     3c. Pedicels 8–15 mm. long; reticulation of leaves prominent on both sides; hair appressed (Colombia, Peru), 1f. var. *chocoensis*.

    3b. Branchlets and leaves beneath softly tomentose, hairs long, mostly erect.........3h.

     3h. Upper side of leaves pilose on the intercostal surface (Colombia).......................1g. var. *Mutisii*.

     3h. Upper side of leaves hirtellous on midrib only (Guianas to Peru. Colombia?)..............1c. var. *tomentosa*.

   3a. Leaves bicolor, blades beneath densely white-canescent with very short hairs; sepals 7–16 mm. long, 2–3 mm. broad; anthers 2–4 mm. long (Guiana to Peru)...................1h. var. *bicolor*.

  3. Pedicels 10–27 mm. long; leaves mostly sparsely pubescent, lateral nerves raised on upper side; sepals 15–45 mm. long, 4–12 mm. broad...4.

   4. Anthers 3.8–4.5 mm. long, short-mucronate; branchlets and petioles more or less pubescent; leaf-blades ovate to ovate-lanceolate or oval, rounded or subcordate at base, the upper side dull, hirtellous along midrib, reticulation little prominent (Upper Orinoco).........4a.

    4a. Leaf-blades beneath sparsely pubescent along nerves, 2. *R. dentata* (typical).

    4a. Leaf-blades beneath softly stellate-pubescent on whole surface, many simple hairs intermixed, often becoming glabrous..............................2a. var. *toxica*.

4. Anthers (4–) 5–8 mm. long, well mucronate at apex; branchlets and petioles glabrous or very sparsely pubescent; leaf-blades narrowly lanceolate to broadly elliptic, rarely ovate-lanceolate, usually greatly narrowed at base, long acuminate at apex, the upper side shining, usually glabrous, reticulation prominent (Brazil, Peru, Amazonas in Venezuela)........3. *R. angustifolia.*

2. Ovary manifestly stipitate; disk high; sepals deciduous; pubescence on leaves not very dense, hairs short, mostly appressed; pedicels 5–20 mm. long; stipules lanceolate or linear-lanceolate...........................5.

5. Flowers small, sepals 8–12 mm. long, 2–3 mm. broad, anthers 2–2.5 mm. long; endocarp thin; leaf-blades small, 6–11 cm. long, 2.5–4 cm. broad, lateral nerves 5–7 pairs, the connecting veins slightly raised (Para)......4. *R. Riedeliana.*

5. Flowers large, sepals 20–32 mm. long, 3–10 mm. broad, anthers 4–5 mm. long; endocarp osseous, very thick, leaf-blades 8–25 cm. long, 3–9 cm. broad, lateral nerves 7–12 pairs...............................................6.

6. Veins connecting lateral nerves on under side of leaf-blades prominent, raised and sharp, ultimate veinlets prominulous; scabrate-pubescent on branchlets, leaves, pedicels, and outside of sepals (Guianas, eastern Brazil)...............................5. *R. pyrifera.*

6. Veins connecting lateral nerves on under side of leaf-blades not prominent, slightly raised, ultimate veinlets faint; smoothly pubescent (from Amazonas in Brazil to the west and north. French Guiana?)...6. *R. Spruceana.*

1. Leaf-blades beneath strikingly canescent or densely grey-tomentose, the tomentum hiding the leaf-surface, hairs often over 0.16 mm. long; coarse reticulation forming prominent, rather open areolae; inflorescences usually several flowered; pedicel disarticulating above the base; sepals persistent; anthers oblong, 2–3 mm. long, not mucronate; ovary sessile or nearly so; fruit grey-spongeous, endocarp crustaceous, thin (South of the Amazon).....7.

7. Pedicels 10–22 mm. long, disarticulating well above the base (3–12 mm. from base); leaf-blades large, 15–19 cm. long, 5–8 cm. broad.......7. *R. canescens.*

7. Pedicels 4–8 mm. long, disarticulating near the base (1–1.5 mm. from base); leaf-blades 6–9 cm. long, 2.5–4 cm. broad....................8. *R. Mansoana.*

### 1. RYANIA SPECIOSA Vahl, Eclog. Am. **1**: 51. t. 9. 1796.

*Ryanaea speciosa* A. DC., Prodr. **1**: 255. 1824.
*?Tetracocyne puberula* Turcz., in Bull. Soc. Nat. Mosc. **36**(2): 555. 1863 (as synonym of *R. speciosa* Vahl.) Appendix Prim. ad Prim. Pt. Cat. Plant. Herb. Univ. Charc. 1857. (fide Turcz.).
"*Ryania pyrifera*" of recent authors, non L. C. Rich.

Branchlets smoothly rusty-tomentose, the stellae with short appressed rays; stipules 3–11 mm. long; petioles closely rusty-tomentose; leaf-blades lanceolate to elliptic or oblong, 11–22 cm. long, 3–8 cm. broad, mostly rounded (sometimes obtuse) at base, acuminate at apex, the under side closely or sparsely stellate-pubescent on principal nerves with short, mostly appressed hairs, sparsely pubescent on intercostal surface, the upper side dull, essentially glabrous, the lateral nerves 10–13 pairs, the reticulation not prominent; inflorescences 1– or 2–flowered; pedicels 3–7 mm. long, disarticulating at base; sepals persistent, lanceolate, 2–4 cm. long, (4–) 5-12 mm. broad, smoothly tomentose outside; anthers linear, 5–7 mm. long, mucronate; disk short, 2 mm. or less high; ovary sessile or nearly so; fruit rough-spongeous, rusty-tomentose, the endocarp thin.

*Type.*—"Habitat in insula Trinitatis. *Ryan.*"

*Illustrations.*—Type: fig. a, fl. nat. size; b, stamen; c, pistil with disk nat. size; d, pistil without disk; e, fr. almost nat. size; f, fr. cut transvers.; g, fr. cut transvers. with seeds removed; h, seed with aril nat. size; i, seed without aril; k, albumen; 1, seed cut longitud. showing embryo; m, embryo nat. size; undesign., branch with lvs. and fl. Baillon (1; det. doubt.): fig. 310, complete fl.; 311, transverse sect. fl. diagram; 312, longitud. sect. fl.; 313, gynaecium. Bannan (2): fig. 2, 4, 7, 8, wood anatomy.

*Distribution.*—The typical variety is confined to Trinidad; reported from rain forests, on sandy soil.

*Specimens examined.*—Trinidad: *Alexander 5684* (S); *Anderson s. n.* (K); *Bot. Gd. Trin. Herb. 1437* & *2600* (US); *N. L. & E. G. Britton 2943* (Aripo savanna; NY, US); *N. L. Britton & T. E. Hazen 380* (Mora Forest, east of Sangre Grande; NY); *1191* (Arcadia Estate, Caura Valley; NY); *N. L. Britton, T. E. Hazen & Walter Mendelson 889* (North Post to Maqueripe; NY); *W. E. Broadway 4423* (Trin. Bot. Gd.; Mich), *5423* (Quarry Rv. forest via Valencia; M), *5639* (Blanchisseuse Rd. near 10½ mile post; F, K, M, S), *6482* (Cumuto forests; M), *9358* (Blanchisseuse Rd., near 1 mile post; A, P, U), *s. n.* (Arena govt. forest, near Cumuto; 1925; S), *s. n.* (Maracas Rd. to Bay; 1927; A, U), *s. n.* (Arena govt. forest; 1933, A, M), *s. n.* (Aripo Rd., near bathing pool; A, M, Ph; also wood coll. at A), *s. n.* (St. Ann's, Cascade; K); *J. C. Cater s. n.* (N. R. R. 1 & 2; NY), *s. n.* (Tree No. 1–5; Tumpuna Reserve; Aug. 20, 1946; NY); *Crueger 63* (Irois; K); *Eggers 1374* (near Arima; US); *A. Fendler 203* (K, P), *382* & *1023* (P); *J. R. Johnston 94* (Brighton; NY); *Otto Kuntze 1060* (Arima; NY); *Lockhart s. n.* (G, K); *F. A. Lodge s. n.* (G); *R. C. Marshall 11601* (Port of Spain; F, K, Y); *Purdie 153* (K); *L. Riley 96* (Arena Reserve; K, NY); *Vahl s. n.* (sketch by Sagot of authentic sp. of Vahl from Herb. Jussieu; P); *R. O. Williams 10096* (Arima-Blanchisseuse Rd., 11–14 mile posts; K).

Concerning *Tetracocyne puberula*, Turczaninow wrote: "comparanda cum *Ryania speciosa* Vahl, cujus specimina authentica non vidi." Whether this species is referable to *R. speciosa* must be ascertained by examination of the type. I have no knowledge on the information given in Appendix Prima (see discussion of Tetracocyne under the genus).

*R. speciosa* is practically confined to the north of Trinidad, where soils are predominantly sandy; it is said to be found in the lowest story in evergreen rain or semi-monsoon forests with a high 20–25 dm. rainfall. Its average distribution per 100 acres is about 25 individuals with a diam. over 10 cm. An average acre in Trinidad is reported to yield 1032 lbs. of air-dried wood. Ryania tends to be locally gregarious and there often are about 125 trees per acre.

See the report on the natural vegetation of Trinidad by J. S. Beard (3).

The Cater Tree-Nos. 1–5 comprise a great number of flowers collected especially to show variation. The relative uniformity in the Trinidad species is remarkable. Ryania on the island has been fairly well investigated by the Forest Department and others, yet not a single example has been reported of the striking var. *bicolor*, or of the narrower sepaled forms of var. *subliflora*, or of the densely pubescent forms of var. *tomentosa*, all of which would have commanded attention by their contrast with the typical variety. The Anderson collection upon which was based the report of "*R. parviflora*" in Fl. Bras. is not ascertained.

The homogeneity noticeable in the isolated Trinidad population of Ryania speaks well for believing the varieties to be natural entities.

*R. speciosa* is said to be a small tree or shrub, 5–6 m. tall or up to 13 m. tall and 4 dm. in girth.

### 1a. **Ryania speciosa** var. **subuliflora** (Sandwith) Monachino, comb. nov.

*R. pyrifera* var. *subuliflora* Sandwith, in Journ. Arn. Arb. **24:** 219. 1943.

Very closely related to the typical variety from which it differs principally in its narrowly lanceolate sepals, 1.8–3 cm. long, 3–6 (rarely 7) mm. broad.

*Type.*—"Essequibo River, in Wallaba forest, Labbakbra Creek, Tiger Creek, August 26, 1937, *Sandwith 1211* (typus); Demerara River, May 1889, *Jenman 4853*; Mazaruni-Kuribrong Divide, in Wallaba forest, *Forest Dept. 893*; Bartica-Potaro road, 83rd milepost, in clump Wallaba bush, June 1933, *Tutin 216* (Herb. Mus. Brit. and Kew)."

*Distribution.*—British and French Guianas, to Pará and Amazonas in Brazil, Loreto and San Martín in Peru and Amazonas in Venezuela; reported from sandy soil, sometimes lateritic ironstone soil, in high or low terra firma forests, and caatingas.

*Specimens examined.*—British Guiana: *N. J. Abbensetts 63* (Moruakow, vicinity of Mt. Roraima; sterile; K); *For Dept. Brit. Guiana 893* (Essequibo, Mazaruni-Kuribrong Divide; K), *3283* (Makauria Creek; NY), *3487* (Potaro Rv., Mahdia Ck., Bartica-Potare Rd.; NY), *4183* (Bartica-Potaro Rd.; NY), *4844* (Mazaruni Rv., Takutu Ck. to Puruni Rv.; NY); *Jenman 4853* (Demerara; pedicels up to 11 mm long, sepals 38 mm. long; K); *Kruk. Herb. 15621–15625* (sterile; NY); *H. Lang 19 & 329* (Mazaruni Rv., Kamakusa; F, NY & F, NY, US); *Sandwith 1211* (type coll.; K, NY, S, U); *Schomburgk s. n.* (Carawaimi Mt.; det. doubt; K); *T. G. Tutin 216* (Bartica-Potaro Rd.; K, U, US). French Guiana: *Leprieur s. n.* (1850; NY, P), *s. n.* (F, K, US); *Martin s. n.* (Cayenne; K); *Melinon s. n.* (1842; P); *Perrottet s. n.* (1820; P); *Poiteau s. n.* (1824; K); *Undesig. coll. s. n.* (Cayenne; P). Brazil: Pará: *Burchell 9621* (K, NY); *Ducke 968 & 1955* (Belém, Bosque Municipal; M, NY, US & NY), *3319* (Belém; G); *Herb. Mus. Para. 9667* (Santa Izabel; G, P, US); *Huber 120* (Belém; G, P, US); *Spruce s. n.* (Santarem, by the Igarapé d'Irurá; K). Brazil: Amazonas: *R. L. Froes 12230/19* (Rio Negro, Tarumansinho; A, NY; stems & roots for tests coll. as *15280*), *21824* (basin of the upper Juruá, Rio Gregorio, Peixote, munic. Eirunepe; NY), *22143* (Rio Negro, Fóz do Caiary; det. doubt.; NY); *E. G. Holt & E. R. Blake 506* (Serra Imeri, near Salto de Huá; NY, US); *Krukoff 7984* (basin of Rio Negro, municip. Manaos; A, M, NY, S, U). Peru: Loreto: *E. P. Killip & A. C. Smith 27113* (Iquitos; F, NY); *G. Klug 162* (Mishuyacu, near Iquitos; F, NY). Peru: San Martín: *G. Klug 2635* (Pongo de Cainarachi, Rio Cainarachi, trib. of Rio Huallaga; sepals up to 8 mm. broad; A, F, GH, M, NY, S). Venezuela: Amazonas: *L. Williams 15522* (Alto Casiquiare, Capihuara; sterile; US).

The varietal[3] epithet was first used in the specific rank by Sprague and Riley (in herb.), but Sandwith recognized the intergrading character of the plant with the Trinidad typical variety.

*R. speciosa* var. *subuliflora* intergrades greatly with var. *minor* and it is not always clearly distinct from var. *tomentosa*.

[3]No distinction is made between varieties and subspecies. By variety is meant that the distinguishing characters are trivial, more or less inconsistant, and the group is closely connected with some similar group by relatively few individuals with intermediate characters.

The Forest Department of British Guiana reported for the year 1945: "In March two men carried out a survey of Ryania bearing areas in the Pomeroon. The survey disclosed an area of 200 acres on both banks of the Tapacooma creek with an average of 970 stems per acre over 1–½″ diameter; in other words, roughly 4–¾ tons green stems per acre."

The same Department also reported that Ryania probably occurs well distributed, locally gregariously, throughout the white sand Wallaba forest from the Pomeroon to the Courantyne. The soil is of the forest type, a very loose porous white sand of variable depth, containing less than 0.1% clay and no iron, pH 4.75.

*R. speciosa* var. *subuliflora* is said to be a tree 7–10 m. tall and 3–8 cm. diam., or up to 14 m. tall and 11 cm. diam.; flowering and fruiting approximately simultaneously at any time of the year; sepals pinkish or pale green, filaments crimson at base, whitish above.

### 1b. **Ryania speciosa** var. **minor** Monachino, var. nov.

"*R. parviflora*" of Eichler, in Mart. Fl. Brs. **13**(1): 493. 1871. Non *Patrisia parviflora* A. DC.

Var. *subuliflorae* valde affinis sed floribus minor, sepalis 1.2–1.6 cm. longis, 2–4 mm. latis, et antheris 2.5–5 mm. longis recedit.

Hardly different from *R. speciosa* var. *subuliflora*, and greatly intergrading with it; flowers smaller, sepals usually 1.2–1.6 cm. long, 2–4 m. broad, anthers 2.5–5 mm. long; reticulation on upper side of leaves prominent. This variety also intergrades with *R. s.* var. *tomentosa*, from which it differs by being much less densely pubescent.

*Type.*—*Sagot 58*, French Guiana, upper Karouany; 1858. (Deposited in the N. Y. Bot. Gd. Herb.)

*Distribution.*—French and British Guiana, Amazonas in Brazil, and extending to Loreto in Peru; reported from caatingas and high forests, sometimes abundant.

*Specimens examined.*—British Guiana: *J. S. de la Cruz 1248* (NW district, Waini Rv.; sepals up to 1.5 cm. long, anthers 4–5 mm. long, fl. almost sessile, lvs. dentate; NY). French Guiana: *Melinon 15* (Maroni; sepals of fruiting specimen up to 2 cm. long; F, NY, P, US), *209* (Rivière du Maroni; approaching var. *subuliflora;* P), *301* (Cayenne; approaching var. *subuliflora;* P), *320* & *338* (Maroni; P), *s. n.* (1863; P); *Sagot 58* (type coll.; Brx, G, NY, K, P, S, U); *Wachenheim 3* (Godebert; F, K, P). Brazil; Amazonas: *Froes 12438/182* (basin of Rio Negro, Macubeta on Rio Marie; sterile; A, NY), *12534a/229* (basin of Rio Negro, Rio Tikin; sterile; A), *12569/293* (Rio Vaupes; sterile; A); *Krukoff 4934* (basin of Rio Juruá, near mouth of Rio Embira, trib. of Rio Tarauaca; A, G, NY); *Spruce 2543* (Rio Vaupes, near panuré; Brx, K, P). Peru: Loreto: *Fernandez 15360/22* (Michuyacu, near Iquitos; NY); *Killip & Smith 29900* & *29932* (Michuyacu, near Iquitos; sepals 13–25 mm. long, 4–6 mm. broad; F, NY & NY); *Klug 7* & *300* & *953* (Mishuyacu, near Iquitos; F, NY & F, NY, US & F, NY).

The varietal epithet was first used in the specific category by Sagot in the herbarium. The collection was then distributed as *Ryania parviflora*, a name which has generally been applied to Sagot's plant. The true *Patrisia parviflora* of De Candolle, however, is a form of *R. speciosa* var. *tomentosa*.

*R. s.* var. *minor* is said to be a shrub up to 7 m. tall; sepals white within, filaments violet-purple.

1c. **Ryania speciosa** var. **tomentosa** (Miq.) Monachino, comb. nov.

*Patrisia parviflora* A. DC., Prodr. **1**: 256. 1824.
*Ryania tomentosa* Miq., in Ann. & Mag. Nat. Hist., Sér. 1, **11**: 15. 1843.
*R. Patrisii* Miq., in Ann. & Mag. Nat. Hist., Sér. 1, **11**: 16. 1843.
*Patrisia tomentosa* M. J. Roem., Synop. Monogr. **2**: 136. 1846.
*Ryania parviflora* Griseb., Fl. Brit. West Ind. 296. 1860.
*R. pyrifera* var. *tomentosa* Sleumer ex Sleumer & Uitt., in Pulle Fl. Surinam (Meded. Kol. Inst. Amster. 30) **3**: 286. 1935.

Branchlets tomentose, hairs often long, erect or ascending, sometimes sub-appressed; leaf-blades beneath softly rusty-tomentose, hairs long (up to 1.3 mm. long), erect or ascending, above shining or dull, hirtellous along midrib, reticulation mostly prominent; sepals 1–2.5 cm. long, 2–5 mm. broad; anthers 4–6 mm. long.

*Type.*—"Hab. Surinami prope plantationem Bergendal, Octob. fl." *H. C. Focke.*

*Illustrations.*—Delessert (15): Fig. 1, transvers. sect. fl. diagram perianth; 2, fl. nat. size; 3, fl. enlarged; 4, fl. with perianth removed showing stigmas and stamens; 5, fl. with perianth partly removed showing pistil, stamens, one sepal; 6, stamens anterior view; 7, stamens posterior view; 8, dehiscent fr. with sepals; 9, fr. valve showing seeds within; 10, seed partly invested by pellicle; 11, seed showing pellicle reflexed; 12, naked seed; 13, seed longitud. cut showing albumen and embryo; 14, cross sect. seed; undesign., branch with lvs. and fl. Reissek (48): fig. 28 & 29, copies of Delessert fig. 10 & 11, a little enlarged; fig. 30, seed in ideal position, parts spread out showing nucleus, integument, chalaza, aril, raphe, hilum.

*Distribution.*—The three Guianas, Pará and Amazonas in Brazil, Loreto in Peru, Amazonas in Venezuela, and doubtfully in Colombia; reported from terra firma, sandy soil.

*Specimens examined.*—British Guiana: *A. A. Abraham 72* (along the Berbice-Rupununi Cattle Trail, Berbice or Demerara County, Waranana Creek; NY); *T. A. W. Davis 2452* (Demerara Rv., Karaba Creek, 110 miles s. of Georgetown; K); *De la Cruz 2028* (Essequibo Rv., vicinity of Bartica; M, NY), *2443* (Demerara Rv., vicinity of Wismar; M, NY), *2567* (Moruka Rv., Pomeroon District, Waramuri mission; M, NY, Ph), *2944* (Pomeroon Rv., Pomeroon District; NY);, *3759* (Waini Rv., NW District; M, NY, Ph), *3870* & *4028* (Wanama Rv., NW District; M, NY, Ph), *4355* (Assakatta, NW District; NY, Ph), *4501* (Potaro Rv., Kaieteur Falls; GH, M, NY, Ph), *4596* (Moruka Rv., Pomeroon District; M, NY, Ph, US); *L. S. Hohenkerk 774* (Berbice Rv., Warunana Creek; K); *Jenman 3888* (Demerara Rv.; K, U), *6616* (K); *A. C. Persaud 174* (Bootooba; F, K, NY); *Schomburgk 616* (Roraima; P). Dutch Guiana: *Focke 385* (type coll.; coll. number doubt.; Brx, K, U); *For. Bur. Surinam 4760* (Sect. O; U); *Hostmann 1229* (G, K, P); *J. F. Hulk 285* (U); *A. Kappler s. n.* (S); *Krukoff 12297* & *12322* (vicinity of Sect. O; NY), *12327* & *12328* & *12332* (vicinity of Sect. O; A, NY); *J. Lanjouw 176* (1933; K, U); *Pulle 82* (lower Saramacca; NY, U); *Stahel 15358* (NY). French Guiana: *R. Benoist 1031* (St. Jean; P); *Melinon s. n* & *s. n.* (Maroni; 1876 & 1877; P); *Patris s. n.* (type coll. *P. parviflora;* G, P, frag. F, photo NY); *Poiteau s. n.* (1826; P). Brazil: Pará: *A. Ginzberger 905* (Santarem; F). Brazil: Amazonas: Froes 21712 (basin of upper Rio Juruá, toward trib. Javary Rv., Parana on Sacado do Ouro Preto; NY), *21815* (basin of Rio Juruá, municip. Eirunepe, Adelia, toward Itecoaby; NY); *E. Ule 5800* (Juruá; G), *9586* (Rio Acre, Mt. Mó; G, K). Peru: Loreto: *L. Williams 3443* (San Antonio; F), *8229* (Iquitos; A, F). Venezuela: Amazonas: *L. Williams 15564* (Casiquiare, Capihuara; bristly tomentose; US). Colombia: *J. Goudot s. n.* (det. doubt.; P); *J. Triana s. n.* (Meta, Villavicencio; det. doubt.; P).

The density and habit of indumentum are not constant. There are examples of *R. s. tomentosa* connecting with both var. *subuliflora* and var. *minor*. The Colombian *Goudot* coll. approaches var. *chocoensis*, and also has long stipules like var. *stipularis*.

*Patrisia parviflora* was collected by Patris "in Cayenna" and deposited in the De Candolle herbarium. An amplified description appears in Delessert (15). The flowers were immature, "alabastra," in the type, which accounts for the lack of manifest disk. The species is within the range of variation in *R. s. tomentosa*.

*R. Patrisii* was proposed by Miquel merely as a new name for *Patrisia parviflora*: "*R. Patrisii*, Vahl, *Patrisia parviflora* De C. Prod. 1. p. 255." Concerning the interpolation of Vahl after the new name, the only way in which Vahl was involved was in Miquel's belief that De Condolle's species truly belonged in Vahl's genus, Ryania. *R. Patrisii* is to be accredited solely to Miquel. A similar interpretation holds for other new combinations and new names published in Ryania by Miquel.

*R. speciosa* var. *tomentosa* is said to be a small tree or shrub, up to 6 m. tall; flowers white, greenish yellow, or yellow and pink.

It is not clear why var. *tomentosa* has been exclusively the only var. collected in Surinam. The two preceding are found in both of the countries flanking Surinam, and var. *bicolor* has been collected from French Guiana to Peru.

### 1d. **Ryania speciosa** var. **stipularis** (Linden & Planchon) Monachino, stat. nov.

*R. stipularis* Linden & Planchon, Trois. Voy. Linden, Bot., Pl. Columb. **1**: 22. 1863. Ex Sprague, in Kew Bull. **1926**: 38. 1926.

Branchlets stellate-pubescent, the stellae often many-rayed, appressed, aggregated so as to present a spotted appearance, or sufficiently close so as to invest the young branchlets with a continuous rusty tomentum; stipules long and relatively persistent (sometimes short and caducous), 6–25 mm. long, often falcate; leaf-blades sparsely pubescent beneath, more densely along the nerves and very sparsely on the intercostal surface, the hairs short, appressed, the upper side of blade shining or somewhat dull, hirtellous along midrib, the reticulation prominent.

There are two indistinct forms of *R. s.* var. *stipularis*, large flowered and small flowered forms, which do not merit formal names:

Sepals 2–3.3 cm. long, 8–13 mm. broad; pedicels about 11 mm. long; anthers 5–6 mm. long . . . . . . . . . . Large-flowered form.
Sepals about 1.8 cm. long, 8 mm. broad; pedicels 5–8 mm. long; anthers 5 mm. long . . . . . . . . . . Small-flowered form.

*Type.*—"Venezuela. Forêts sombres du versant nord de la chaine de Carabobo, alt. 812 m., *Linden*."

*Distribution.*—Fairly wide-spread in northern Venezuela; reported from monsoon forest, alt. up to 1000 m.

*Specimens examined.*—Venezuela: Carabobo: *Funck 760* (Valencia; G, P); *Linden 1522* (Montagne de Puerto Cabello, alt. 2000 ft.; P). Districto Federal: *Cruger s. n.* (Cerro del Avila; 1859; K); *Alfredo Jahn 457* (El Lemón; US); *Funck & Schlim 156* (Caracas; G, P); *Moritz 1216* (K, P); *Pittier 8067* (Hacienda Puerto La

Cruz, Coastal Range; A, GH, US), *9219* (Hacienda El Lemón and vicinity, valley of Puerto Cruz; G, NY, US). Merida: *A. Fendler 2332* (near Tovar; K). Miranda: *Pittier 5991* (Siguire Valley, Guinand Estate; F, M, NY, P, S, US). Sucre: *F. Tamayo 2166* (Los Altos; US). Loc. undesign.: *Alfredo Jahn 500a* (US).

Only five copies of the original publication were distributed, one to a botanical garden, and the remaining four to individuals. Sprague suggests that this does not constitute public distribution under Art. 36 of the International Rules.

*R. speciosa* var. *stipularis* is said to be found usually in groups in the mountainous region of municipality Santa Fe, State of Sucre, especially in the vicinity of Los Altos de Santa Fe, developing best in humid soil and under the shade of large trees. It is here found usually in flower and fruit in winter. It is said to be a tree 2–4 m. tall, with radial branching and pyramidal crown; fruits up to 6 cm. diam., reddish and visible at a distance. Examination of 75 fruits showed an average of 144 seeds per fruit. An average of 35 seeds weigh 1 gram. Under cultivation, the average time from pollination of 75 flowers to seed harvesting was 70 days (in Guatemala).

1e. **Ryania speciosa** var. **panamensis** Monachino, var. nov.

Var. typicae valde affinis, sed floribus minoris, sepalis 1.3–1.8 cm. longis, 4–6 mm. latis, et antheris 2.5–3.5 mm. longis recedit.

Very closely related to the typical variety, from which it differs in its smaller flowers; sepals 1.3–1.8 cm. long, 4–6 mm. broad; anthers 2.5–3.5 mm. long.

*Type.*—*H. von Wedel 2886*, Panama, prov. de Bocas del Toro, vicinity of Chirique Lagoon, Big Bight; Oct. 27, 1941. (Deposited in the N. Y. Bot. Gd. Herb.)

*Distribution.*—Known at present only from the Bocas del Toro area of Panama.

*Specimens examined.*—Panama: *J. H. Hart s. n.* (Chiriqui; rec'd 6/86; K); *Wedel 306* (Bocas del Toro; M), *1928* (Bocas del Toro, Old Bank Island; Jan. 31, 1941; GH), *1947* (Bocas del Toro, Old Bank Island; Feb. 1, 1941; fruit; M), *2119a* (Bocas del Toro, vicinity of Chiriqui Lagoon, Old Bank Island; Feb. 17, 1941; GH), *2886* (type coll.; GH, M, NY).

*R. speciosa* var. *panamensis* is said to be a small tree up to 10 m. tall; flowers greenish or white.

1f. **Ryania speciosa** var. **chocoensis** (Triana & Planch.) Monachino, stat. nov.

*R. chocoensis* Triana & Planch., in Ann. Sc. Nat., Sér. 4, **17**: 117. 1862.
*Patrisia chocoensis* Warb., in Engl. & Prantl. Natürl. Pflanzenfam. **3** (6a): 50. 1893.

Branchlets closely minutely tomentose, hairs short and appressed; stipules 3–6 mm. long; pedicels 8–15 mm. long; leaf-blades with prominent close reticulation on both sides, sparsely pubescent with short hairs beneath, shining above, hirtellous along midrib; sepals 1–3 cm. long, 3–7 mm. broad; anthers 3–5 mm. long.

*Type.*—"Port de la Buenaventure, côte du Pacifique," *J. Triana.*

*Distribution.*—Widespread in Colombia, particularly in the western

departments, and extending to Peru; reported from forests or thick jungle, alt. up to 100 m.

*Specimens examined.*—Colombia: Choco: *W. A. Archer 1842* (Rio Atrato, Quibdó, F, NY, US); *J. Ball s. n.* (Buenaventura; 1882; K); *Lehmann herb. 8019* Buenaventura; F, K); *Triana s. n.* (type coll.; 1851–1857; Brx, G, K, NY, P; also photo at NY). Valle: *J. Cuatrecasas 15716* (costa del Pacifico, Rio Yurumanguí; NY). Cauca: *Lehmann herb. 8997* (Timbique Rv.; K, NY); *C. Longfield 715* Gorgona Is.; K); *H. Pittier 589* (Pacific coastal zone, Dagua valley, Córdoba; NY, US). Huila: *Lehmann herb s. n.* (B. T. 1099; Guágua; G, K, NY). Santander: *M. T. Dawe 423* (lower Magdalena, Carare Rv.; K, US); *Oscar Haught 2025* (Magdalena Valley, between Sogamoso and Carare Rvs., vicinity of Barrana Bermeja; US). Vaupes: *J. Cuatrecasas 6847* (selva del Vaupes, Mitú; pedicel 7 mm. long; US). Loc. undesign.: *J. C. Mutis s. n.* (Killip no. 667; US). Peru: *M. MacLean s. n.* (K).

*R. speciosa* var. *chocoensis* is said to be a small tree or shrub 2–7 m. tall; flowers conspicuous, faintly fragrant, sepals white within, ochraceous-green exteriorly, stamens white, disk and pistil red, markedly protandrous, visited by butterflies; fruits red-cheeked like peaches and with the consistency of green peaches.

### 1g. **Ryania speciosa** var. **Mutisii** Monachino, var. nov.

Var. *chocoensi* valde affinis sed foliis subtus tomentosis et supra pilosulis non stellatis recedit.

Branchlets rusty tomentose, hairs somewhat erect; leaf-blades softly tomentose beneath, the stellae with long erect rays, sometimes few (2–3–) rayed or reduced to simple hairs, the upper side hirtellous along midrib, pilose with scattered erect simple hairs on the intercostal surface.

*Type.*—*José Celestino Mutis s. n.* (Killip no. 4460), Colombia (Plant. Exped. Bot. Mutisii 1783–1808), Tolima-Cundinamarca area. (Deposited in the U. S. Nat. Herb.)

*Distribution.*—Known only from the Mutis collection.

*Specimens examined.*—Colombia: *Mutis s. n.* (Killip no. 4460; type coll.; G, F, S, US), *s. n.* (Killip no. 4484, 4487, 4611; US).

### 1h. **Ryania speciosa** var. **bicolor** (A. DC.) Monachino, stat. nov.

*Patrisia bicolor* A. DC., Prodr. **1:** 256. 1824.
*Ryania Candollei* Miq., in Ann. & Mag. Nat. Hist., Sér. 1, **11:** 16. 1843.
*R. bicolor* Eichl., in Mart. Fl. Bras. **13**(1): 491. 1871. (in observ.). Sagot, in Ann. Sci. Nat., Sér. 6, Bot. **11:** 144. 1881.

Leaf-blades ovate to lanceolate, 6-18 cm. long, 3–7 cm. broad, strikingly bicolor, beneath closely microscopically conescent-tomentose, the stellae very short rayed (under 0.16 mm. long) and so close as to cover the entire leaf surface, above shining or dull, hirtellous along midrib; flowers small, sepals mostly 0.7–1.6 cm. long, 2–3 mm. broad; anthers 2–4 mm. long.

*Type.*—"in Cayennê," *Patris.*

*Distribution.*—French Guiana, Amazonas in Brazil, Loreto in Peru; reported from caatinga, terra firma, high forest, alt. 100 m.

*Specimens examined.*—French Guiana: *Patris s. n.* (type; photo in NY; sketch by P. Sagot, 1882, in P); *Poiteau herb. s. n.* (ex herb. Ad. Brongniart; P); *L. C.*

*Richard herb. s. n.* (Kourou; P). Brazil: Amazonas: *R. L. Froes 12425/169* (basin of Rio Negro, Rio Icana; A, NY), *12464/207* (Rio Vaupes, Corocoro; A, NY), *12475/218* (basin of Rio Negro, Macubeta on Rio Marié; NY), *12536/230* (basin of Rio Negro, Rio Tikie; NY), *22140* (Rio Negro, Foz do Caiary; NY), *22244* (Rio Icana, Acoty Iacanga; NY); *Weiss & Schmidt s. n.* (upper Rio Negro; 1907–1908; NY). Peru: Loreto: *F. de Castelnau s. n.* (Sacramento; P); *Fernandez 23* (Mishuyacu, near Iquitos; NY); *G. Klug 795* (Mishuyacu, near Iquitos; F, NY).

*R. Candollei* is merely a new name proposed by Miquel for *Patrisia bicolor*.

Eichler observes under *R. Mansoana*: "An huc ducenda *Ryania bicolor* DC. Prodr. 1. 256? E descriptione vix differt?" The reference is interpreted to signify that Eichler thought *Ryania bicolor* to be the correct combination for the plant described by De Candolle; in other words, the name constitutes a new combination by Eichler. However, the author questioned whether *R. bicolor* and *R. Mansoana* are truly distinct, and this might possibly be regarded as publication in synonymy. P. Sagot, in 1881, referred to the plant as "*R. bicolor*. Patrisia DC."

The hoary under side of the leaves of *R. s.* var. *bicolor* is a very striking feature. There are no intermediates to confuse delimitations from the glabrescent varieties. However, specimens having this canescence (e. g. *Fernandez 23*, *Klug 795*) and completely lacking it (*Fernandez 22*, *Klug 300*, *R. speciosa* var. *minor*) are almost identical in all other respects; the specimens here cited as examples were collected at Mishuyacu, the two *Fernandez* collections on the same day and the *Klug* numbers at the same altitude.

Analogous conditions of leaves hoary or glabrous beneath are found in *Casearia arborea* (L. C. Rich.) Urban. In this instance, as well as many others, students have not regarded pubescence as significant enough to suggest formal distinction.

*R. speciosa* var. *bicolor* is said to be a small tree or shrub 2–7 m. tall.

### 2. RYANIA DENTATA (H.B.K.) Miq., in Ann. & Mag. Nat. Hist., Sér. 1, **11**: 16. 1843.

*Patrisia dentata* H.B.K., Nov. Gen. et Sp. **5**: 357. 1821.
*P. affinis* H.B.K., Nov. Gen. et. Sp. **5**: 357. 1821.
*Ryania Kunthii* Miq., in Ann. & Mag. Nat. Hist., Sér. 1, **11**: 16. 1843.
*R. dentata* var. *typica* Dugand, in Caldasia **3**: 267. 1945.

Branchlets more or less pubescent, stellae with rays ascending or erect, hairs sometimes simple; stipules about 3 mm. long, hispidulous; petioles pubescent like the branchlets; leaf-blades ovate to ovate-lanceolate or oval, 6–12 cm. long, 3–5 cm. broad, rounded or subcordate at base, sparsely pubescent along nerves beneath, dull above and hirtellous along midrib, the margins entire or faintly serrate, the reticulation not too prominent; inflorescence 1- or 2- flowered; pedicels 10–17 mm. long, greyish-rusty tomentose, some of the hairs ascending or erect; sepals persistent, 2.8–3.2 cm. long, 5–8 mm. broad; anthers linear, 3.8–4.5 mm. long, short-mucronate at apex; disk short; ovary sessile or nearly so; fruit rusty-tomentose, the endocarp thin.

*Type*.—"Crescit locis umbrosis, arenosis, inter Atures et Maypures. (Missiones del Orinoco). *B*."

*Distribution.*—Upper Orinoco (Amazonas, Venezuela); reported from rocky or sandy places, in shade or clearings, alt. 100 m.

*Specimens examined.*—Venezuela: Amazonas: *Bonpland 891* (type; photo 13633 from Berlin; NY); *E. G. Holt & E. R. Blake 807* (Puerto Ayacucho; NY, US); *L. Williams 13105 & 13114* (Puerto Ayacucho; F, K, NY, US & A, F), *15932* (Raudal de Atures; US). ?Venezuela: Districto Federal: *Humboldt herb. s. n.* (Caracas; photo 13638 from Berlin; distributed under an unpublished name credited to H.B.K.; locality is very doubtful; NY).

The type of *Patrisia affinis* was collected not far from the vicinity of *R. dentata*: "Crescit locis scopulosis, prope Carichana, ad ripam Orinoci. *B.*" It originally was noted as being scarcely distinct from the latter, in the synonymy of which it was placed by Sprengel in 1825. Eichler and nearly all other students have followed this disposition.

*R. Kunthii* is merely a substitute name which Miquel used for *Patrisia affinis.*

*R. dentata* is said to be a tree or shrub 1–1.5 m. tall; sepals yellow within, filaments red.

2a. RYANIA DENTATA var. TOXICA Dugand, in Caldasia **3:** 267. 1945.

Differs from the typical variety in its pubescence; under side of leaf-blades softly stellate-pubescent on whole surface with ascending or erect hairs, many simple hairs often intermixed, the indumentum being variable and sometimes lacking; pedicels 10–17 mm. long.

*Type.*—"*Juan B. García sine num.*, Departamento de Boyacá, llanos orientales; Granja Ganadera de Casanare en Orocué, rio Meta, Agosto 24, 1944 (Herb. Nac. Colomb. Duplicado en U. S. Nat. Herb.)"

*Distribution.*—Upper Orinoco (Colombia); reported from plains, edge of forest, alt. 100 m.

*Specimens examined.*—Colombia: Boyacá: *García s. n.* (type coll.; US), Vichada: *Oscar Haught 2805* (along R. Vichada near San José de Ocune, Los Llanos, edge of forest, alt. about 100 m.; A, US).

Barely distinct from the typical variety. E. P. Killip at first named *Haught 2805* as a new species (in herb.) but later deposited the plant with *R. dentata* in the U. S. National Herbarium.

*R. dentata* var. *toxica* is said to be a shrub 1 m. tall; flowers dull red, strongly protandrous.

3. **Ryania angustifolia** (Turcz.) Monachino, comb. nov.

*Tetracocyne angustifolia* Turcz., in Bull. Soc. Nat. Mosc. **36**(2): 555. 1863. Appendix Prim. ad Prim. Pt. Cat. Plant. Herb. Univ. Charc. 1857. (fide Turcz.).
*Ryania acuminata* Spruce ex Eichl., in Mart. Fl. Bras. **13**(1): 492. 1871.
*Patrisia acuminata* Kuntze, Rev. Gen. Plant. **1:** 45. 1891.
*Ryania sauricida* Gleason, in Phytologia **1:** 106. 1934.

Branchlets glabrous or very sparsely pubescent, stellae with rays ascending or erect; stipules 2–7 mm. long, hispidulous; petioles sparsely pubescent or glabrous; leaf-blades narrowly lanceolate to broadly elliptic, rarely ovate-lanceolate, 10–18 cm. long, 2–8 cm. broad, usually greatly narrowed at base, long-acuminate at apex, glabrous beneath or very sparsely pubescent on nerves with appressed hairs, the upper side shining, the lateral nerves 7–8 pairs, raised, the reticulation prominent

and close; inflorescence 1– or 2–flowered; pedicels 10–27 mm. long, rusty tomentose, some of the hairs ascending or erect; sepals persistent, 1.5–4.5 cm. long, 4–12 mm. broad; anthers linear, (4–) 5–8 mm. long, mucronate at apex; disk short; ovary sessile or nearly so; fruit rusty tomentose, the endocarp thin.

*Type.*—"e Guiana Brit. *Rich. Schomb. coll. 1 No 993.*" According to Sandwith the coll. is probably from Brazil, Rio Negro, near San Gabriel.

*Illustrations.*—Nakarai & Sano (40): fig. 1, two pieces of roots; fig. 2–4, anatomical transverse sect. of roots; fig. 5, anatomical radial and tangential longitud. sect. of roots. Bannan (2): fig. 1, 3, 5, 6, 9–37, wood anatomy.

*Distribution.*—Common in the Brazilian Amazonas, extending to Pará in Brazil and Loreto in Peru, and up the Rio Negro to Amazonas in Venezuela; in forests, up to 170 m. alt., usually along rivers, in restinga, varzea, inundated land, or terra firma, in rocky places or clay soil.

*Specimens examined.*—Brazil: Pará: *O. A. Derby s. n.* (Santarem; 1871; pedicel 1 cm. long; det. doubt.; NY); *Ducke 2934* (Rio Tapajóz, Itaituba; G). Brazil: Amazonas: *J. T. Baldwin Jr. 3259* (Rio Negro; US, wood sample in sect. of Wood Technology); *Ducke 350* (Rio Negro; A, F, M, NY, S, US), *15373* (Rio Urubú; NY), *35697* (Rio Negro; S, U, US); *R. L. Froes 12373/133 & 12418/162* (Rio Negro; A, NY), *12526/220 & 12528/222 & 12550/244* (Rio Negro; A), *21696 & 21731* (upper Juruá; NY), *22067* (Barcelos; NY), *22083 & 22174 & 22190 & 22196 & 22210 & 22214a-c & 22215* (Rio Negro; NY); *E. G. Holt & W. Gehriger 366 & 380* (F, G, M, NY, S, US & NY, US); *Krukoff 5815* (type coll. *R. sauricida;* A, G, NY), *7643* (Rio Purus, near Sepatini; as *R. sauricida*, "roots are under study by chemists and pharmacologists"; NY); *Schomburgk 993* (type coll.; G, K, NY, P, U); *R. Spruce 2240* (Rio Negro, San Gabriel; P), *2508* (Rio Vaupes, near Panuré, K, P), *3783* (type coll. *R. acuminata;* Brx, K, NY, P); *G. H. H. Tate 970* (Rio Negro, Yucabí; NY); *E. Ule 5034* (Rio Juruá, Bom Fim; K), *5034b* (Rio Juruá; Sept. 1900; G). Peru: Loreto: *W. Fox 103* (Encanto; K). Venezuela: Amazonas: *L. Williams 14922* (Rio Guainía, lower San Miguel, Isla Laolao; approaching *R. dentata;* US).

Concerning *Tetracocyne angustifolia* Turczaninow wrote: "videtur nova species *T. angustifolia* dicenda, praeter folia angusta glaberrima pedunculis saepe bifloris distincta," and this is the only description available to me (see discussion of Tetracocyne under the genus). "Praeter" refers to *T. puberula*, which Turczaninow allocated to *R. speciosa.* Although inadequately characterized in a sketchy article and poorly known, the type of *T. angustifolia* was designated. The name unfortunately has priority over *R. acuminata*, and it is with considerable reluctance that I propose the new combination.

The type of *Ryania acuminata* is thus cited: "Ad fluv. Rio Negro prov. do Alto Amazonas: *Spruce 3783.*; in Guiana britannica: *Rich. Schomburgk 993.*—Najas." The type is *Spruce 3783*, from Rio Negro, "insula fl. Negro supra fluvii Padauari, Dec. 1854." Eichler borrowed the specific name from Spruce's manuscript; he noted that the Schomburgk plant differed somewhat in its short-acuminate leaves almost glabrous beneath; and the latter is the type of *Tetracocyne angustifolia.*

The type of *R. sauricida*, *Krukoff 5815*, from Sepatini on the Purus River, has immature flowers but can be determined with reasonable confidence as merely a broad-leaved form of *R. angustifolia*, a form quite common in the species. Leaf-width is highly variable here and cannot serve as a basis for any distinction.

*Ule 5034b* is named "*Patrisia pyrifera* var. *glabrescens* Pilg." on the herbarium sheet. This trinomial has not been published in the literature examined by me.

*R. angustifolia* is closely related to, and sometimes approaches, *R. dentata*. Transitional forms of the two are found particularly in the conjoining areas of distribution.

4. RYANIA RIEDELIANA Eichl., in Mart. Fl. Bras. **13**(1): 491. t. 99, fig. 2. 1871.

*Patrisia Riedeliana* Kuntze, Rev. Gen. Plant. **1**: 45. 1891.

Branchlets somewhat roughened, rusty tomentose; stipules linear-lanceolate, about 7 mm. long, 1 mm. broad; petioles tomentose; leaf-blades elliptic to lanceolate-oblong, small, 6–11 cm. long, 2.5–4 cm. broad, the under side pubescent with appressed hairs, lateral nerves 5–7 pairs, veins connecting lateral nerves slightly raised, the upper side dull, hirtellous along midrib; inflorescence 1- or 2-flowered; pedicels 5–9 mm. long; flowers small; sepals 0.8–1.2 cm. long, 2–3 mm. broad; anthers 2–2.5 mm. long, short-mucronate at apex; disk about 3 mm. high; ovary stipitate, stipe about 3 mm. long; fruit short-stipitate, small (about 1 cm. long), rusty tomentose, spongeous material thin, the endocarp thin.

*Type.*—"Habitat in umbrosis siccis petrosis prope Santarem prov. Pará: *Riedel.*—Najas."

*Illustrations.*—Type: leafy branch with fl.; fl. showing pistil, disk, filaments, and portion of calyx; fl. showing disk; sepals; anthers, anterior and posterior views, turgid with pollen and pollen shed; ovary, several views, cross sect.

*Distribution.*—Known at present only from Pará, Brazil.

*Specimens examined.*—Brazil: Pará: *Ducke 4849* (Obidos; G); *Riedel s. n.* (type coll.; K, NY, P, U); *Spruce 588* (Santarem; K, P); *J. W. Traill 28* ("Jauari"; K).

*R. Riedeliana* is poorly known. It is said to be a tall shrub with white flowers.

5. RYANIA PYRIFERA (L. C. Rich.) Sleum. & Uitt., in Pulle Fl. Surinam (Meded. Kol. Inst. Amster. 30) **3**: 286. 1935.

*Patrisia pyrifera* L. C. Rich., in Act. Soc. Hist. Nat. Par. **1**: 110. 1792.
*Ryania Sagotina* Eichl., in Mart. Fl. Bras. **13**(1): 491. 1871.
*Patrisia Sagotiana* Kuntze, Rev. Gen. Plant. **1**: 45. 1891.

Branchlets roughly stellate-pubescent; stipules lanceolate, about 5–6 mm. long, 1.5 mm. broad; petioles roughly pubescent; leaf-blades elliptic to oblong, 8–25 cm. long, 3–9 cm. broad, rounded to acute at base, the under side roughly pubescent, lateral nerves 10–12 pairs, veins connecting lateral nerves raised and sharp, ultimate veinlets prominulous, the upper side dull or somewhat shining, hirtellous along midrib, reticulation not prominent; inflorescence 1- or 2-flowered; pedicels 6–12 mm. long; sepals deciduous, 2–3.2 cm. long, 3–10 mm. broad, roughly tomentose on surfaces which were exposed in bud; anthers linear, about 4–5 mm. long, mucronate at apex; disk conspicuous, 3–5

mm. high; ovary manifestly stipitate, stipe 3-5 mm. long; fruit stipitate, roughly rusty-tomentose, the endocarp very thick (about 5 m. thick), sculptured.

*Type.*—"E Cayenna missarum a domino *Le Blond*," L. C. Richard Herb., Paris.

*Illustrations.*—Warburg (60): one fl. (det. of sp. doubt.).

*Distribution.*—Common in the three Guianas, extending to Pará and with an outpost in eastern Amazonas, Brazil; reported from dry capoeira, old secondary forests, high terra firma.

*Specimens examined.*—French Guiana: *R. Benoist 308* (P); *Gabriel s. n.* (1802; G); *Herb. Expos. Coloniale s. n.* (P); *Le Blond s. n.* (type coll.; leaf fragm. at F, G, photo at NY, P); *Leprieur s. n.* (herb. A. de Jussieu; 1824?; P), *s. n.* (1838; A, Brx, F, G, GH, NY, P, US), *s. n.* (1839; G), *s. n.* (1840; G, P), *s. n.* (herb. Maire; P); *Melinon 5* (Maroni; 1855; F, P, US), *135* & *166* (Maroni; P), *s. n.* (herb. Sagot; 1855; P); *Patris s. n.* (Cayenne; P); *Poiteau s. n.* (1824; K), *s. n.* (1826?; P); *Sagot 57* (type coll. *R. Sagotiana;* Brx, fragm. at F, G, K, photo at NY, P, S, U). Dutch Guiana: *B. W. herb. 4176* (Tapanahoni Rv., near Doemansingi; K, NY, S, U, US); *Krukoff 12292* & *12319* & *12320* (vicinity of Sectie O; NY), *12321* (vicinity of Sectie O; A, NY). British Guiana: *Jenman 4098* (upper Demerara Rv.; K); *L. S. Hohenkerk s. n.* (For. Dept. 774A; Buruma Creek, Berbice; K). Brazil: Pará: *Ducke 8518* (Faro; G). Brazil: Amazonas: Manáos: *Ducke 345* (Colonia Joao Alfredo; A, NY, Y), *15374* (NY), *15375* (coll. no. ?; beyond Colonia Campos Selleo; NY); *Krukoff 8019* (basin of Rio Negro, along road to Aleixo; A, G, M, NY, S, U).

The type collection of *R. pyrifera*, consisting of excellent material with both flowers and fruits, is identical with that of *R. Sagotiana* ("*Sagot pl. Guian. exsicc. n. 57*," collected at Karouany in 1858).

Sleumer and Uittien, who made the transfer from Patrisia, did not know the true identity of the species. Like almost all other authors since 1806 they believed it to be synonymous with *R. speciosa.*

*R. pyrifera* is said to be a small tree or shrub about 1.5–8 m. tall; flowers with purplish centers; according to Hohenkerk, the fruits are globular, about 4 cm. diam., with persistent style, dehiscent in two valves while on tree, pleasant scented on being cut.

### 6. **Ryania Spruceana** Monachino, sp. nov.

Arbor parva, ramulis dense stellato-pubescentibus, pilis ex radiolis brevibus adpressis vel usque ad patentibus compositis; stipulis lanceolatis 5–6 mm. longis; laminis foliorum late elliptico-oblongis, 13–23 cm. longis, 4–7 cm. latis, subtus in costa nervisque lateralibus stellato-pubescentibus (radiolis pilorum brevibus adpressis); nervis lateralibus utrinque 7–10 supra depressis; nervis intercostatis subtus indistinctis, reticulo non prominente; floribus 1 vel 2 axillaribus; pedicello 1 usque ad 2 cm. longo; sepalis deciduis oblongis 2.5–5 cm. longis, 5–10 mm. latis, ad apicem obtusis, dorso indumento subruguloso; disco ca. 5 mm. longo; antheris 4–5 mm. longis ad apicem mucronatis; ovario valde stipitato, stipo ca. 3 mm. longo.

Small tree; branchlets smoothly stellate-tomentose, hairs short, appressed to ascending; stipules lanceolate, 5–6 mm. long; leaf-blades broadly elliptic-oblong, 13–23 cm. long, 4–7 cm. broad, stellate-pubescent on midrib and lateral nerves beneath, hairs short, appressed, lateral nerves 7–10 pairs, depressed above, intercostal veins faint beneath, reticulation not prominent; inflorescence 1- or 2-flowered; pedicels

about 15 mm. long (up to 20 mm.); sepals deciduous, oblong, 2.5–3 cm. long, 5–10 mm. broad, obtuse at apex, outside indumentum slightly roughened; disk about 5 mm. high; anthers 4–5 mm. long, mucronate at apex; ovary manifestly stipitate, stipe about 3 mm. long; fruit stipitate, 3–4 cm. diam., roughly rusty-tomentose, the endocarp very thick (2–6 mm. thick), sculptured.

*Type.*—*Spruce 3773*, Brazil, Amazonas, Rio Negro, near San Gabriel do Cachoeira; Dec. 1854. (Deposited in Kew herb.)

*Distribution.*—Amazonas, Brazil, to Santander in Colombia, Amazonas in Venezuela, Loreto in Peru, and doubtfully in French Guiana; reported from recent woods, shady woods or forests on high or low terra firma, up to 1000 m. alt., in sandy soil.

*Specimens examined.*—Brazil: Amazonas: *R. L. Froes 22109* (Rio Negro, Tapurucoara; NY), *22373* (Rio Negro, Rio Enuixy, Matosinho; NY); *Spruce 3773* (type coll.; Brx, K, P); Undesign. coll. (Rio Negro; P). Peru: Loreto: *G. Tessmann 4096* (mouth of Rio Santiago; G, NY). Colombia: Santander: *Oscar Haught 1775* (San Juan Valley, vicinity of Puerto Berrio, between Carare and Magdalena Rv.; GH, NY, P, US); *José Celestino Mutis s. n.* (Killip no. 4622; loc.?; US); *William C. Steere 7013* (El Playón; US). Venezuela: Amazonas: *L. Williams 14819* (Rio Guainía, Victorino; A, US). French Guiana: *Leprieur 299* (det. doubt.; G).

*R. Spruceana* bears unmistakeable affinity with *R. pyrifera*. It is essentially the western equivalent of the latter.

*Leprieur 299* is anomalous. The sepals apparently are persistent and the stipe of the ovary is short. Like in typical *R. Spruceana*, however, the endocarp is thick and the sepals are broad. One might speculate whether the specimen is an hybrid between *R. pyrifera* and *R. speciosa* var. *subuliflora*.

*R. Spruceana* is said to be a small tree 3–7 m. tall, with simple branches crowded toward top of stem; flowers showy, sepals whitish within, reddish or rosy outside, base of filaments and ovary bright red; fruits rusty-brown or purplish.

### 7. RYANIA CANESCENS Eichl., in Mart. Fl. Bras. **13**(1): 490. t. 99, fig. 1. 1871.

*Patrisia canescens* Kuntze, Rev. Gen. Plant. **1:** 45. 1891.

Branchlets tomentose; stipules 5 mm. long; petioles tomentose; leaf-blades elliptic, sometimes broadest above middle, 15–19 cm. long, 5–8 cm. broad, acute or rounded at base, the under side densely grey-tomentose, long-rayed stellae abundant, rays up to 0.5 mm. long, lateral nerves about 10 pairs, reticulation prominent and coarse, forming rather open areolae, the upper side dull, hirtellous with often simple hairs along midrib and sparsely so on the intercostal surface, the margins obscurely serrate; inflorescence about 3-flowered; pedicels 10–22 mm. long, disarticulating well above base (3–12 mm. from base); sepals persistent, 1.5 cm. long, about 5 mm. broad, grey-brownish tomentose outside; anthers oblong, 2-3 mm. long, not or barely mucronate; disk short; ovary sessile or nearly so; style sparsely villose toward apex as well as near base; fruit grey-spongeous, the endocarp thin.

*Type.*—"In fruticetis ad Ribeirâo ad Rio Madeira, prov. Mato Grosso, Majo flor.: *Riedel.*—Najas."

*Illustrations.*—Type: leafy branch with fl.; fl. analysis showing pistil, filaments, disk, and portion of sepals; cross sect. of ovary; anthers anterior and posterior view.

*Distribution.*—Known at present from only the following two collections in Matto Grosso, Brazil.

*Specimens examined.*—Brazil: Matto Grosso: *J. T. Baldwin 2954* (Quajará-Marin, about 1 mile north of town at edge of savanna; "only time seen"; US); *Riedel s. n.* (type coll.; ex herb. hort. Petropolitani; K, U).

*R. canescens* is exceedingly close to *R. Mansoana.* Additional collections are needed to ascertain the precise delimitations of the two. The toxicology of these has not been investigated.

### 8. RYANIA MANSOANA Eichl., in Mart. Fl. Bras. **13**(1): 490. t. 99, fig. 3. 1871

*Patrisia Mansoana* Kuntze, Rev. Gen. Plant. **1**: 45. 1891.

Branchlets greyish-tomentose, some of the hairs ascending or erect; stipules short, 5–8 mm. long; petioles tomentose; leaf-blades coriaceous on maturity, oval, sometimes broadest above middle, 6–9 cm. long, 2.5–4 cm. broad, rounded or subcordate at base, rarely narrowed, rounded and mucronate at apex, sometimes acute, the under side densely greyish-tomentose, hairs frequently 0.16 mm. long or longer, lateral nerves about 7 or 8 pairs, deliquescing into a reticulum before reaching margin of leaf, reticulation prominent and coarse, forming rather open areolae, the upper side dull, hirtellous along midrib or glabrous, the margins entire or obscurely serrate; inflorescence about 4-flowered; pedicel 4–8 mm. long, disarticulating near base (1–1.5 mm. from base); sepals persistent, 1–1.5 cm. long, 3–6 mm. broad, grey-brownish tomentose outside; anthers oblong, 1.75–3 mm. long, not or barely mucronate; disk short; ovary sessile or nearly so.

*Type.*—"Habitat locis siccis in Serra de Cuiabá prov. Mato Grosso: *Patricio da Silva Manso.*—Oreas."

*Illustrations.*—Type: fr., seed, embryo.

*Distribution.*—Matto Grosso in Brazil, extending to Rio Madeira in Amazonas; reported from dry places in high fields.

*Specimens examined:* Brazil: Matto Grosso: *Banderia Anhanguéra s. n.* (Inst. Bot. São Paulo 42686; loc.?; NY); *J. T. Baldwin Jr. 3100* (Rio Arinos, Braco; US); *De Silva Manso 87* (type coll.?; Cujabá; 1832; G), *s. n.* (type coll.; G). Brazil: Amazonas: *Ducke 35176* (Rio Madeira, Humaytá; G, P, S, US).

Closely allied to *R. canescens*, which see.

Eichler observed: "An huc ducenda *Ryania bicolor* DC. Prodr. 1. 256? E descriptione vix differt." Such scruple concerning its distinction from an earlier described species does not, in my judgment, relegate *R. Mansoana* to *nomen provisorium*.

Eichler added that the species is strongly similar to *Rich. Schomburgk 932* from British Guiana. This Roraima collection is cited under coll. no. *616*, *R. speciosa* var. *tomentosa* in the present paper. In its closer stellae with shorter rays it somewhat approaches *R. speciosa* var. *bicolor*.

*R. Mansoana* is said to be a small shrub ½–1 m. tall; flowers fragrant, white with purple stamens.

## DOUBTFUL SPECIES

*Tetracocyne puberula.*—see *Ryania speciosa* in previous discussion.

*Ryania Schomburgkii* Klotzsch.—Reference to this name is made by Harms (*in* Engler, Bot. Jahrb. **15**: 614, 616, 618. 1893) in connection with anatomical studies. This *nomen nudum* also appears in Solereder (56), who makes allusion to Harms' studies, otherwise it has not been noticed in the literature examined. Of the species cited in the present paper, Schomburgk collected the following: *R. angustifolia*, *R. speciosa* var. *subuliflora*, *R. speciosa* var. *tomentosa*.

*Spruce 2730.*—Turczaninow (Bull. Soc. Nat. Mosc. **36**(2): 555. 1863) writes "Tertia species memorata verosimiliter etiam nova Quid genus Rayaniae aff. ad fl. Uaupes in Brasilia septemtrionali a cl. Spruce lectum, No. *2730*?" For comments on the original work, "Appendix," see previous discussion under the genus. The Spruce collection cited has not been located; those examined from Amazonas, Brazil, are of *R. angustifolia* and *R. speciosa* var. *minor.*

## BIBLIOGRAPHY

1. **Baillon, H.** 1873. Histoire des Plantes, **4**: 272–273, figs. 310–313.
2. **Bannan, M. W.** 1943. Wood structure of *Ryania*. Amer. Jour. Bot. **30**: 351–355, figs. 1–37.
3. **Beard, J. S.** 1946. The natural vegetation of Trinidad. Oxford Forestry Memoirs **20**: 73, 75, 77, 82, 99, 100, 108, 115, 119, 124, 141.
4. **Bentham, G.** 1861. Notes on Bixaceae and Samydaceae. Jour. Proc. Linn. Soc., Second Suppl. **5**.—Botany: 82.
5. **Bigger, J. H., Decker, G. C., Wright, J. M.,** and **Petty, H. B.** 1947. Insecticides to control the European Corn Borer in field corn. Jour. Econ. Entom. **40**: 401–404.
6. **Bishopp, F. C.** 1946. The insecticide situation. Jour. Econ. Entom. **39**: 451–452.
7. **Bourne, A. I.** 1947. Insecticides for the control of the European Corn Borer. Massachusetts Agri. Exp. Station Bull. **441,** Annual Report: 35.
8. **Bret, G.** 1930. Estudo chimico dos glucosides da raiz da *Ryania acuminata*. Bol. Escola de Chim. Indust. **1**: 48–50.
9. **Brown, R.** 1822. An account of a new genus of plants, named *Rafflesia*. Trans. Linn. Soc. London **13**: 221.
10. **Carruth, L. A.** 1947. Recent developments in Squash Borer control with DDT. Farm Research. N. Y. State Agric. Exp. Station at Geneva and Cornell Univ. Agric. Exp. Station at Ithaca, Bulletin **13**(1): 11.
11. **Carruth, L. A.,** and **Hervey, G. E. R.** 1947. DDT and other insecticides for Squash Borer control. Jour. Econ. Entom. **40**: 716–721.
12. **Cortés, S.** 1897. Flora de Colombia, **1**: 74–75.
13. **Decker, G. C.** 1947. What chemicals for Corn Borer control? Agricultural Chemistry **2**(7): 20.
14. **Decker, G. C., Apple, J. W., Wright, J. M.,** and **Petty, H. B.** 1947. European Corn Borer control on canning corn. Jour. Econ. Entom. **40**: 395–400.
15. **Delessert, B.** 1837. Icones Selectae Plantarum, **3**: 8–9, t. 14, figs. 1–14.
16. **Dills, L. E.,** and **Odland, M. L.** 1946. New Insecticides for Cabbage Caterpillars. Vegetable Growers News. Pennsylvania State College.
17. **Dills, L. E.,** and **Odland, M. L.** 1948. Cabbage Maggot insecticide experiments. Vegetable Market Growers Jour. **77**(3): 10.
18. **Dills, L. E.,** and **Odland, M. L.** 1948. New insecticides may reduce vegetable yields. Vegetable Market Growers Jour. **77**(3): 26.
19. **Dills, L. E.,** and **Odland, M. L.** 1948. Cabbage Maggot insecticidal tests. Jour. Econ. Entom. **41**: 98–101.
20. **Dills, L. E.,** and **Odland, M. L.** 1948. Several chemicals better than mercury compounds in combatting Cabbage Maggot. Science for the Farmer. Pennsylvania State College Agric. Exp. Station, Supp. **2**, Bull. **488**: 9.

21. **Dills, L. E.,** and **Odland, M. L.** 1948. DDT for good control of Cabbage Caterpillar. Science for the Farmer. 69th Annual Report, Pennsylvania State College. Supp. 3, Bull. **488**: 10.
22. **Dugand, A.** 1945. Noticias botanicas Colombianas, IV. Caldasia **3**: 267–269.
23. **Edwards, G. W., Weiant, E. A., Slocombe, A. G.,** and **Roeder, K. D.** 1948. The action of ryanodine on the contractile process in striated muscle. Science **108**(2804): 330–332.
24. **Eichler, A. G.** 1871. Bixaceae. *In* Martius, Flora Brasiliensis **13**(1): 427–428, 488–494, t. 99.
25. **Folkers, K., Rogers, E. F.,** and **Heal, R. E.** 1946. Insecticides U. S. Pat. 2,400,295.
26. **Harms, H.** 1893. Über die Verwertung des anatomischen Baues für die Umgrenzung und Einteilung der Passifloraceae. Bot. Jahrb. **15**: 614, 616, 618, 624, 526.
27. **Hassett, C. C.** 1948. Effect of ryanodine on the oxygen consumption of *Periplaneta americana*. Science **108**(2797): 138.
28. **Hough, W. S.,** and **Hill, C. H.** 1947. Research in farming. The 1946–1947 Annual Report, Virginia Agricultural Experiment Station, p. 32.
29. **Huckett, H. G.** 1946. DDT and other new insecticides for control of Cauliflower Worms on Long Island. Jour. Econ. Entom. **39**: 184–188.
30. **Ingram, J. W., Bynum, E. K.,** and **Charpentier, L. J.** 1947. Tests with new insecticides for control of the Sugarcane Borer. Jour. Econ. Entom. **40**: 779–781.
31. **Ivy, E. E.,** and **Ewing, K. P.** 1947. Laboratory and cage tests with newer insecticides to control cotton insects. Jour. Econ. Entom. **40**: 568–569.
32. **Kulash, W. M.** 1947. Benzene hexachloride, DDT, and *Ryanex* to control Soybean Caterpillars. Jour. Econ. Entom. **40**: 927–928.
33. **Kulash, W. M.** 1948. New insecticides for Corn Earworm control. Jour. Econ. Entom. **41**: 387–389.
34. **Kulash, W. M.** 1948. New insecticides for the control of Soybean Caterpillars. Soybean Digest **8**(8): 16.
35. **Kuna, S.,** and **Heal, R. E.** 1948. Toxicological and pharmacological studies on the powdered stem of *Ryania speciosa*, a plant insecticide. Jour. Pharm. & Exp. Therap. **93**: 407–413.
36. **Le Cointe, P.** 1930. O principio activo das plantas do genero *Ryania* ou *Patrisia* (Flacourtiaceas). Bol. Escola Chim. Industr. **1**: 43–47.
37. **Le Cointe, P.** 1934. Arvores e plantas uteis. A Amazonia Brasileira **3**: 273–274.
38. **Merz, K. W.** 1930. Über Bestandteile einer bisher unbekannten Droge (*Patrisia acuminata*). Arch. Pharm. **268**: 592–593.
39. **Mezey, K.** 1947. Venenos de flecha de Colombia. Rev. Acad. Colomb. **7**: 322-323, Graph No. 9.
40. **Nakarai, S.,** and **Sano, T.** 1934. Toxikologische Untersuchung über giftige Bestandteile von *Ryania acuminata*. Arch. Pharm. **272**: 1–4, figs. 1–5.
41. **Neiswander, C. R.,** and **Richardson, B. H.** 1948. Sweet Corn without Borers. Farm and Home Research **33**: 76–81.
42. **Pepper, B. P.,** and **Carruth, L. A.** 1945. A new plant insecticide for control of the European Corn Borer. Jour. Econ. Entom. **38**: 59–66.
43. **Persoon, C. H.** 1806. Synopsis Plantarum, seu Enchiridium Botanicum **2**: 69.
44. **Polivka, J. B.** 1947. DDT for controlling the larvae of the Japanese Beetle. Farm and Home Research **32**: 107.
45. **Rainwater, C. F.,** and **Bondy, F. F.** 1947. New insecticides to control Boll Weevil and Cotton Aphid. Jour. Econ. Entom. **40**: 371–373.
46. **Record, S. J.** 1941. American woods of the family Flacourtiaceae. Tropical Woods **68**: 55.
47. **Record, S. J.** 1944. Keys to American Woods. Tropical Woods **78**: 40.
48. **Reissek, S.** 1843. Ueber das Wesen der Keimknospe. Linnaea **17**: 659–660, t. 20, figs. 28–30.
49. **Richard, A.** 1845. Botanique.—Plantes vasculaires. *In* Sagra, Histoire Physique, Politique et Naturelle de l'Ile de Cuba: 93–94.
50. **Robertson, O. T.** 1948. Tests with DDT, benzene hexachloride, and *Ryania* for Pink Bollworm control. Jour. Econ. Entom. **41**: 120–121.

51. **Rogers, E. F., Koniuszy, F. R., Shavel, J.,** and **Folkers, K.** 1948. Plant insecticides. I. Ryanodine, a new alkaloid from *Ryania speciosa* Vahl. Jour. Amer. Chem. Soc. **70:** 3086–3088.
52. **Sagot, P.** 1880. Catalogue des plantes phanérogames et cryptogames vasculaires. Ann. Sci. Natur., Sér. 6, Bot. **10:** 363; **11:** 143–144. 1881.
53. **Sandwith, N. Y.** 1943. New and noteworthy Polypetalae from British Guiana. Jour. Arnold Arbor. **24:** 219–220.
54. **Seiferle, E. J.,** and **Frear, D. E. H.** 1948. Insecticides derived from plants. Ind. & Eng. Chem. **40**(4): 689.
55. **Sleumer, H.,** and **Uittien, H.** 1935. Flacourtiaceae. *In* Pulle, Flora of Surinam **3**(1): 285–287 K. Ver. Kol. Inst. Amsterdam, Med. 30, Afd. Handelsmuseum No. 11.
56. **Solereder, H.** 1908. Systematic Anatomy of the Dicotyledons. (Trans. by Boodle, L. A., and Fritsch, F. E.; revised by Scott, D. H.) **1:** 88, 89–90.
57. **Triana, J.,** and **Planchon, J. E.** 1862. Prodromus Florae Novo-Granatensis **1:** 115–118. (Reprinted from Ann. Sci. Natur. Bot., Sér. 4, **17.**)
58. **Vahl, M.** 1796. Eclogae Americanae **1:** 51, t. 9, figs. a–m.
59. **Walpers, G. G.** 1843. Repertorium Botanices Systematicae **2:** 218.
60. **Warburg, O.** 1893. Flacourtiaceae. *In* Engler and Prantl, Die natürlichen Pflanzenfamilien, **3**(6a): 3, 4, 10, 46, 49–50, fig. 18L.
61. **Wheeler, E. H.** 1945. DDT and *Ryanex* to control Oriental Fruit Moth on quince. Jour. Econ. Entom. **38:** 281–282.
62. **Wheeler, E. H.,** and **La Plante, Jr., A. A.** 1946. DDT and *Ryanex* to control Oriental Fruit Moth: their effect upon parasite populations. Jour. Econ. Entom. **39:** 211–215.
63. **Wilson, J. D.,** and **Sleesman, J. P.** 1947. Some of the newer pesticides damaging plants. Farm and Home Research **32**:58–63.

# Chemical Composition of Rye Grown on Different Soil Types in Ontario, Canada

## Part I. Nitrogen Content of the Plants[1]

F. L. Wynd[2] and G. R. Noggle[3]

### INTRODUCTION

The reports of Wynd and Noggle (4, 5, 6) indicate that certain characteristics of the soils in the vicinity of Midland, Douglas County, Kansas, are related to the nitrogen content in the leaves of oats and rye, harvested at the jointing stage. The present study is an extension of these investigations to include the relationships between five conspicuously different soil types in the vicinity of Wallaceburg, Ontario, to the nitrogen content of Rosen rye plants harvested at the beginning of the jointing stage.

The importance of grass as a source of protein in many important stock food preparations, as well as the relationships between soil properties and the productivity of pastures, suggests the importance of extending the results obtained in specific localities to other, and widely different, localities; for it is only by duplicating field studies under various conditions that generally applicable conclusions can be reached. The study of the relationships of specific nutritional factors to the composition of plants is also of interest to the plant physiologist who may not be concerned primarily with the practical applications of the results of his studies to the problems of agriculture.

### MATERIALS AND METHODS

Widely different soil types exist in the vicinity of Wallaceburg, Ontario. This situation presents a confusing problem to the farmer who is concerned with the productive management of land in this area, but it offers the student of plant nutrition an almost ideal situation for a comparative study of the nutritional environment which these soils present to plants. The comparative value of strikingly different soils may be studied within such a small area that climatic and geographical factors are approximately similar for all.

The soils selected for study in the present investigation were chosen to represent the greatest possible differences in type within a limited area. The chemical details are presented in the tables, and the soil types may be described as follows:

*Clyde Silt Loam.*—This soil type is a poorly drained, deep, black, friable silt loam. It is underlain by blue-grey clay. It is neutral to alkaline in reaction, and it is very high in organic matter.

*Muck.*—This soil is very high in organic matter, nitrogen, and

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[1]The expenses incurred by the present study were supported in part by a grant from the Cerophyll Laboratories, Inc., Kansas City, Missouri.

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replaceable bases. Its reaction is about neutral, or alkaline. It is often underlain with marl.

*Berrien Sand.*—This soil is an imperfectly drained sand, underlain by clay. It is low in organic matter, and is usually acid in reaction. Many sites, however, exhibit a reaction nearly neutral or even slightly alkaline.

*Thames Clay Loam.*—This soil is an imperfectly drained, reddish-brown, friable clay loam or silty clay loam. It is neutral to alkaline in reaction.

*Sandy Muck.*—This soil appears to be a sandy variation of muck. It is very similar to muck except that it contains only about one half as much organic matter.

A commercial strain of Rosen rye was planted April 15, 1941, and the harvests were made just before general jointing occurred. This stage of growth was defined arbitrarily as the stage when about 10 per cent of the grass plants had produced joints. The first harvest was made on May 10, or 25 days after seeding. The second harvest was made on June 1, or 22 days after the first harvest. It was believed that more significant comparisons of the effects of soil type on the composition of the grass could be made if the successive harvests were compared at similar physiological stages of development rather than at similar chronological ages.

The crops were dehydrated in an Arnold hot-air dehydrator immediately after cutting. Samples of the meal were then sent by mail to the laboratory for analysis. Two harvests were made from each soil type. A sample of the upper 8 inches of the soil was taken for analysis at the time of each cutting. The discussion below describes the relationships that were observed between the properties of the soils and percentage of nitrogen in the rye plants. The data for the Thames Clay Loam at the time of the second harvest are lacking because this sample was lost in the mail.

The total nitrogen in the grass was determined by the Kjeldahl procedure modified to include the nitrogen of nitrates as recommended by the Association of Official Agricultural Chemists (1). The analyses of the soils were carried out by the procedures described by Wynd and Noggle (6) and Wynd and Romig (7). The phosphorus fractions 1, 2, 3, and 4 were determined by the procedures of Bray and Dickman (3). The $P_1$ phosphorus was determined by the rapid test procedure for adsorbed phosphate described by Bray (2).

The numbers of the points appearing in the figures correspond to the numbers of the soils which appear in the tables. The points in the figures enclosed by solid circles refer to data for the first crop; those enclosed by broken circles refer to the data for the second crop. The graphical units used in the figures are the same as those which appear in the tables.

## EXPERIMENTAL RESULTS

### I. Relationships between Certain Soil Components

Since the object of the present study was to compare specific properties of the five types of soils with the percentage of nitrogen in the

immature rye plants, it is necessary to determine at the outset, the relationships which exist between the various components in the soils themselves. Various properties of soils are inherently related to each

TABLE 1. *Chemical characteristics of the five soil types at the time of the first harvest.*

| Soil | Base exchange capacity (m. e. per 100 gms.) | | Total replaceable bases (m. e. per 100 gms.) | Base saturation (per cent) | pH | $CaCO_3$ (per cent) | Loss on ignition (per cent) | Nitrogen (per cent) |
|---|---|---|---|---|---|---|---|---|
| | Total | Organic | | | | | | |
| 1. Clyde Silt Loam........ | 27.3 | 19.2 | 35.7 | 131 | 7.3 | 4.82 | 10.50 | 0.43 |
| 2. Muck......... | 77.6 | 64.9 | 74.5 | 97 | 7.0 | 1.36 | 46.00 | 1.73 |
| 3. Berrien Sand.. | 8.3 | 5.2 | 13.1 | 158 | 7.2 | 2.22 | 3.44 | 0.13 |
| 4. Thames Clay Loam....... | 34.1 | 19.0 | 44.5 | 131 | 7.5 | 2.86 | 11.70 | 0.45 |
| 5. Sandy muck... | 32.2 | 25.7 | 63.5 | 197 | 7.4 | 14.25 | 14.80 | 0.66 |

TABLE 2. *Chemical characteristics of the five soil types at the time of the second harvest.*

| Soil | Base exchange capacity (m. e. per 100 gms.) | | Total replaceable bases (m. e. per 100 gms.) | Base saturation (per cent) | pH | $CaCO_3$ (per cent) | Loss on ignition (per cent) | Nitrogen (per cent) |
|---|---|---|---|---|---|---|---|---|
| | Total | Organic | | | | | | |
| 1. Clyde Silt Loam....... | 27.4 | 18.4 | 44.6 | 163 | 7.6 | 5.30 | 11.00 | 0.46 |
| 2. Muck......... | 97.5 | 82.4 | 97.4 | 100 | 7.3 | 2.75 | 52.00 | 2.00 |
| 3. Berrien Sand.. | 10.8 | 6.6 | 15.6 | 144 | 7.4 | 0.42 | 3.82 | 0.15 |
| 4. Thames Clay Loam....... | ...... | ...... | ......... | ......... | ...... | ...... | ........ | ....... |
| 5. Sandy muck... | 33.0 | 20.9 | 51.7 | 157 | 7.4 | 7.79 | 14.70 | 0.62 |

TABLE 3. *Individual replaceable bases in the five soil types at the time of the first harvest.*

| SOIL | REPLACEABLE BASES (m. e. per 100 gms.) | | |
|---|---|---|---|
| | Ca | Mg | K |
| 1. Clyde Silt Loam............................. | 30.2 | 5.60 | 0.170 |
| 2. Muck............................................ | 83.9 | 9.40 | 0.135 |
| 3. Berrien Sand................................. | 10.1 | 2.43 | 0.154 |
| 4. Thames Clay Loam......................... | 38.2 | 5.82 | 0.282 |
| 5. Sandy muck.................................. | 57.7 | 6.62 | 0.113 |

other in their magnitude, and unless these relationships are known, erroneous conclusions may result concerning the effect of specific properties.

Various properties of the soils are tabulated in tables 1 to 6 inclusive.

Graphs were prepared showing all possible quantitative relationships between these properties. Only those figures showing consistent relationships are included in the present paper. It was found that all the consistent inter-relationships between the soil properties studied could be indicated by their individual relationships to the amount of organic matter in the soil.

TABLE 4. *Individual replaceable bases in the five soil types at the time of the second harvest.*

| Soil | Replaceable Bases (m. e. per 100 gms.) | | |
|---|---|---|---|
| | Ca | Mg | K |
| 1. Clyde Silt Loam | 39.0 | 5.57 | 0.138 |
| 2. Muck | 88.4 | 15.20 | 0.125 |
| 3. Berrien Sand | 12.4 | 2.85 | 0.063 |
| 4. Thames Clay Loam | ..... | ..... | .... |
| 5. Sandy Muck | 46.6 | 5.47 | 0.098 |

TABLE 5. *Phosphorus fractions in the five soil types at the time of the first harvest.*

| Soil | Phosphorus Fractions (parts per million) | | | | |
|---|---|---|---|---|---|
| | Fraction 1 | Fraction 2 | Fraction 3 | Fraction 4 | $P_t$ |
| 1. Clyde Silt Loam | 11 | 17 | 49 | 161 | 33 |
| 2. Muck | 15 | 25 | 85 | 165 | 40 |
| 3. Berrien Sand | 13 | 29 | 52 | 158 | 59 |
| 4. Thames Clay Loam | 16 | 23 | 65 | 235 | 44 |
| 5. Sandy Muck | 10 | 17 | 63 | 217 | 38 |

TABLE 6. *Phosphorus fractions in the five soil types at the time of the second harvest.*

| Soil | Phosphorus Fractions (parts per million) | | | | |
|---|---|---|---|---|---|
| | Fraction 1 | Fraction 2 | Fraction 3 | Fraction 4 | $P_t$ |
| 1. Clyde Silt Loam | 11 | 23 | 49 | 175 | 41 |
| 2. Muck | 9 | 13 | 32* | 158 | 29 |
| 3. Berrien Sand | 9 | 21 | 52 | 184 | 51 |
| 4. Thames Clay Loam | ........ | ........ | ........ | ........ | . |
| 5. Sandy Muck | 12 | 20 | 86 | 202 | 51 |

*This value is probably erroneously low.

The data presented in figures 1 to 4 inclusive show that the amounts of organic matter, indicated as "loss on ignition," total replaceable bases, percentage of nitrogen, and the parts per million of fraction 3 phosphorus all very concomitantly. Since calcium comprises such a large fraction of the total amount of replaceable bases, it would follow that replaceable calcium would also tend to vary quantitatively with

the amount of organic matter. These relationships make it evident that it would be impossible to separate the specific effects of organic matter, base exchange capacity, replaceable bases, nitrogen, and fraction 3 phosphorus on the composition of the grass.

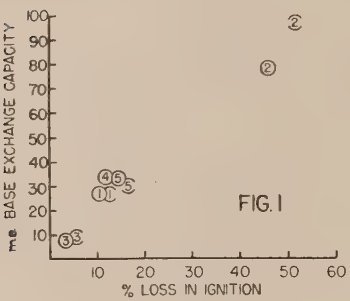



FIG. 1

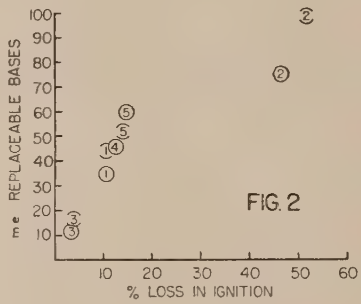



FIG. 2

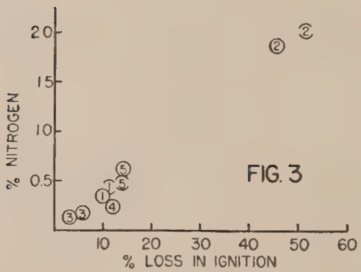



FIG. 3

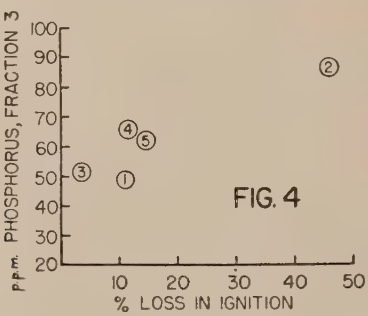



FIG. 4

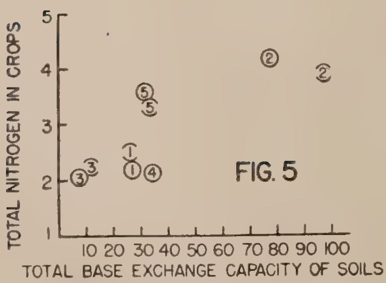



FIG. 5

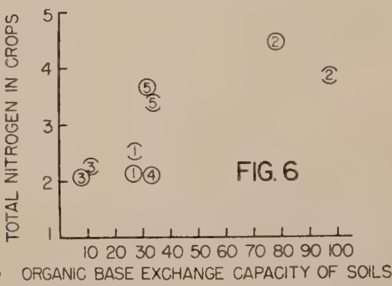



FIG. 6

The situation described above would exist for base-saturated soils. If unsaturated soils were compared, the amounts of organic matter and nitrogen would not be expected to vary quantitatively with the amounts of replaceable bases. Under these conditions, Wynd and Noggle (4, 5) have shown that it is possible to separate the effect of nitrogen from that of the replaceable bases on the nitrogen content of the leaves of oats and rye.

## II. Relationships of Soil Properties to the Nitrogen Content of the Immature Rye Plants

The percentage of total nitrogen in the two crops grown on each of the five types of soils are tabulated in table 7. The relationships between the various properties of the five types of soils to these percentages of nitrogen are discussed below in the order in which the soil properties are listed in the tables.

*Total base exchange capacity.*—Figure 5 shows that there is a positive relationship between the magnitude of the total base exchange capacity of the 5 types of soils and the percentage of nitrogen in both cuttings. A comparison of the data for the two cuttings indicates no noticeable difference in the relationships of either of the cuttings to this soil property.

TABLE 7. *Percentage of total nitrogen in the 2 crops of Rosen Rye grown on 5 types of soils.*

| Soil | Total Nitrogen in Crops (per cent) | |
|---|---|---|
| | First | Second |
| 1. Clyde Silt Loam | 2.15 | 2.54 |
| 2. Muck | 4.41 | 3.83 |
| 3. Berrien Sand | 2.11 | 2.20 |
| 4. Thames Clay Loam | 2.09 | .... |
| 5. Sandy Muck | 3.57 | 3.41 |

*Organic base exchange capacity.*—The organic matter comprises the major part of the total base exchange capacity of the soils studied, consequently the data presented in figure 6 exhibit a relationship almost identical to that evidenced in figure 5.

*Total replaceable bases.*—The data presented in figure 7 indicate very clearly a positive relationship between the total amount of replaceable bases in the soils and the percentage of nitrogen in the crops.

It should be noted that all the soils studied were slightly to conspicuously calcareous. The use of ammonium acetate as the leachate for the determination of the replaceable bases in calcareous soils introduces an error since this solution dissolves a portion of the carbonates. The qualitative relationship between the observed replaceable bases and the percentage of nitrogen in the crops, however, is not disturbed by this error because the soils having the greater amounts of replaceable bases also contain the greater amounts of carbonate. The relationships between the replaceable bases in the soils and the nitrogen in the crops therefore is authentic but appears accentuated in the graphs.

*Degree of base saturation.*—It is evident from figure 8 that the degree of the base saturation of the soils was not clearly related to the percentage of nitrogen in the crops. Since the base exchange capacity of the soils studied was largely due to the relatively large amounts of organic matter present, the degree of base saturation may be indirectly regarded as the ratio of replaceable bases, as determined in the ammonium acetate

leachate, to the organic matter in the soil. Since figure 2 indicated the close quantitative relationship between the amount of organic matter and the amount of replaceable bases in the soils, it is to be expected that the degree of base saturation would not show a quantitative rela-

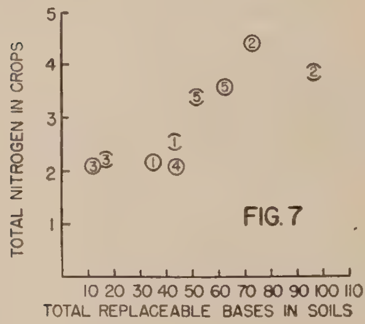


FIG. 7

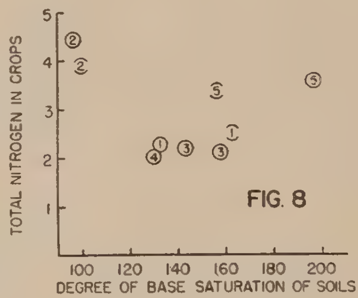


FIG. 8

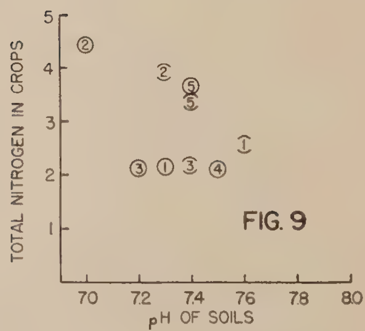


FIG. 9

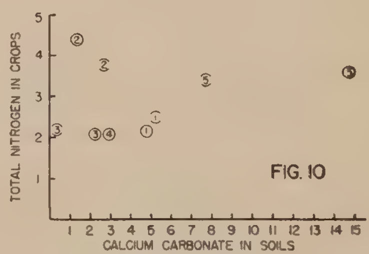


FIG. 10

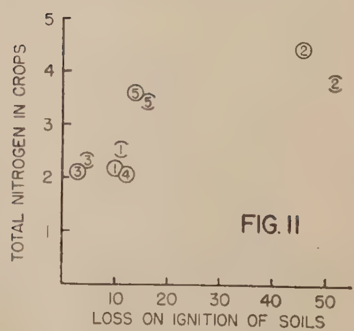


FIG. 11

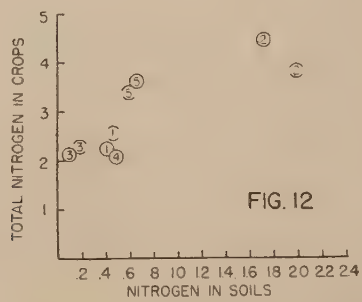
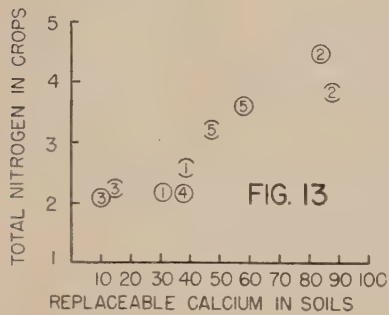


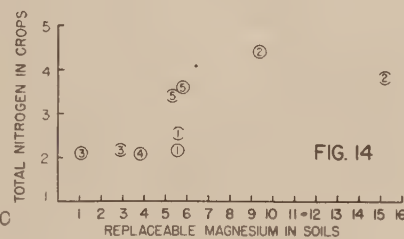
FIG. 12

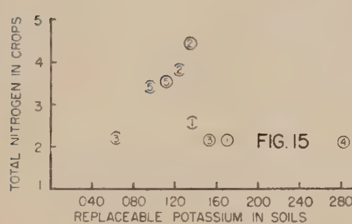
tionship to the percentage of nitrogen in the crops. If the soils had been unsaturated, this situation might not have occurred.

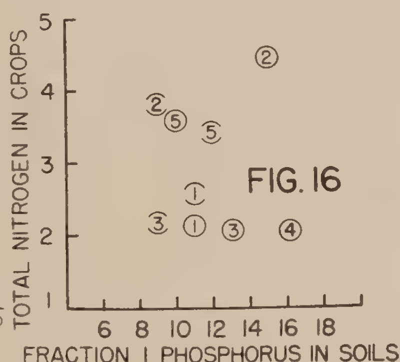
*p*H.—The evidence presented by figure 9 indicates that there is no relationship between the pH of the soils and the percentage of nitrogen in the crops. This situation is reasonable for saturated soils. In unsaturated soils, the relationship of the pH to the degree of base

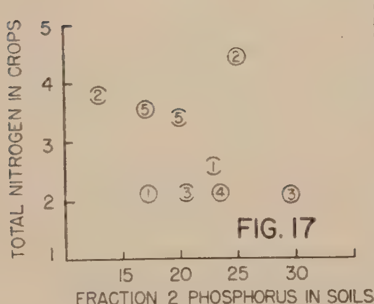
saturation might, in turn, be indirectly related to the ratio of the replaceable bases to the nitrogen in the soil. Under these conditions, the pH of the soil might show a consistent relationship to the nitrogen in the leaves of plants.

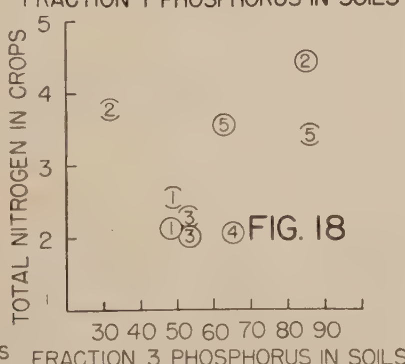



*Calcium carbonate.*—An examination of figure 10 indicates that the amount of calcium carbonate, at least when present in the concentrations observed in the soils studied, bears no consistent relationship to the percentage of nitrogen in the immature rye.

*Organic matter.*—The amount of organic matter in the soils, as

indicated by the percentage loss on ignition, is shown by figure 11 to be closely related to the nitrogen content of both cuttings.

*Nitrogen*.—The data presented graphically in figure 12 show that the percentage of nitrogen in the soil was closely related to the concentration of nitrogen in the crops. The degree of relationship was about the same for both harvests. Since the close relationship between the organic matter and nitrogen in the soils is shown by figure 3, the distribution of the points in figures 11 and 12 is almost identical.

*Replaceable calcium*.—The amounts of replaceable calcium in the soils are shown by figure 13 to bear a very definite relationship to the percentage of nitrogen in the crops. In fact, figure 13 shows one of the most conspicuously positive relationships observed in the present study. It should be remembered, however, that this relationship is accentuated in the figure because of the error introduced by the use of ammonium acetate as the leachate, because the soils containing the greater amounts of replaceable calcium were also those containing the most carbonate.

*Replaceable magnesium*.—Figure 14 shows that the relationship between the replaceable magnesium in the soils to the concentration of nitrogen in the crops is generally positive, although this relationship is not as clearly so as in the instance of replaceable calcium. It has been shown that calcium comprises the major part of the total replaceable bases, and that the total bases follow very closely the amount of organic matter (nitrogenous) which in turn is closely related to the base exchange capacity. It is to be expected, therefore, that replaceable calcium would be more clearly related to the nitrogen content of the plant than is the replaceable magnesium.

*Replaceable potassium*.—The amount of replaceable potassium in the soils is shown by figure 15 to bear no consistent relationship to the percentage of nitrogen in the plants.

*Fraction 1 phosphorus*.—The amount of phosphorus in the soils indicated as fraction 1 is shown by figure 16 to bear no relationship to the amount of nitrogen observed in the leaves.

*Fraction 2 phosphorus*.—The data presented in figure 17 indicate that there is no relationship between the amount of phosphorus in the soils indicated as fraction 2 and the concentration of nitrogen in the crops.

*Fraction 3 phosphorus*.—Figure 18 indicates that there is a positive relationship between the amount of phosphorus in the soils in fraction 3 and the percentage of nitrogen in the crops if the data for the second cutting from the muck soil are disregarded. This relationship is especially evident if the data for the first cutting alone are observed. This appears permissible since the data in the tables suggest the phosphorus determination of the muck soil at the time of the second cutting was probably erroneously low. It should be pointed out that fraction 3 is the only phosphorus fraction in the soil which was positively related to the organic matter-nitrogen-replaceable base complex.

*Fraction 4 phosphorus*.—Figure 19 indicates that the amount of fraction 4 phosphorus in the soils was not related to the nitrogen content of the plants.

*$P_1$ phosphorus.*—It is apparent from the data presented in figure 20, that the amount of phosphorus in the soil indicated as the $P_1$ fraction was not related to the amount of nitrogen in the plants.

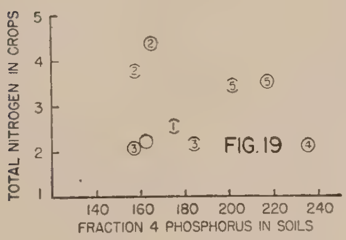



FIG. 19

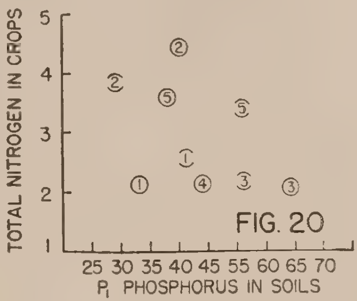



FIG. 20

## DISCUSSION

A survey of all the data presented in figures 1 to 4 inclusive, shows that the magnitudes of the organic matter, base exchange capacity, total replaceable bases, nitrogen, and fraction 3 phosphorus all varied more or less quantitatively with each other. Each of these soil factors was positively related to the percentage of nitrogen in the crops, but since they vary concomitantly, the data presented do not indicate which, if any, of these factors is predominantly influential in determining the percentage of nitrogen in the crops. It seems reasonable, however, to assume that the amount of nitrogen in the soil probably was the most effective factor.

A concentration of 20 per cent protein in commercially dehydrated grass is generally assumed to indicate a product of satisfactory quality. This concentration of protein would correspond to 3.2 per cent of nitrogen. On the basis of the soils studied, it follows that satisfactory soils in the vicinity of Wallaceburg, Ontario, for the production of high quality dehydrated grass are characterized by soil properties of the following magnitudes: base exchange capacity, 30 milliequivalents per 100 grams; total replaceable bases, as determined by an ammonium acetate leachate, 50 milliequivalents per 100 grams; loss on ignition, 13 per cent; nitrogen, 0.50 per cent; replaceable calcium, 45 milliequivalents per 100 grams; and fraction 3 phosphorus, 60 parts per million. It is apparent from the values stated that the best soils of the vicinity for the purpose described are saturated with bases and are calcareous, although a definite quantitative relationship between the actual amount of carbonate and the suitability of the soil was not observed.

If only base saturated soils are considered, it seems probable that the determination of the base exchange capacity, or the percentage of nitrogen would serve as a useful index of the relative suitability of the soils in the vicinity of Wallaceburg for the production of grass of high protein content. Only those characteristics of the soils determined in the present study which were quantitatively related to the organic matter complex were related to the amount of nitrogen in the immature rye plants.

## SUMMARY

1. Rosen rye was grown on five conspicuously different types of soils in the vicinity of Wallaceburg, Ontario. Two cuttings were made just before jointing occurred, and the percentage of total nitrogen was determined.

2. A sample of the upper 8 inches of each soil was taken at the time the cuttings were made, and the magnitudes of the following characteristics determined: total base exchange capicity, organic base exchange capacity, total replaceable bases, degree of base saturation, pH; the amounts of calcium carbonate, organic matter, nitrogen, and replaceable calcium, magnesium, and potassium; and the amounts of phosphorus present in five different fractions.

3. It was observed that the magnitudes of the following properties of the soils varied concomitantly: organic matter, nitrogen, base exchange capacity, total replaceable bases, replaceable calcium, and fraction 3 phosphorus.

4. Each of the above soil properties was positively related to the percentage of nitrogen in the crops. Only those soil properties related quantitatively to the amount of organic matter exhibited this positive relationship.

5. Satisfactory soils in the vicinity of Wallaceburg for the purpose described are characterized by soil properties of the following magnitudes: base exchange capacity, 30 milliequivalents per 100 grams; loss on ignition, 13 per cent; nitrogen, 0.50 per cent; fraction 3 phosphorus, 45 parts per million.

6. If only saturated soils are considered, the determination of the base exchange capacity and the percentage of nitrogen probably would serve to determine the relative values of soils in the vicinity of Wallaceburg, Ontario, for the production of immature rye of high nitrogen content.


## LITERATURE CITED


1. **Association of Official Agricultural Chemists.** Official and tentative methods of analysis. Fourth ed. Assoc. Official Agri. Chem. Washington, D. C. 1935.
2. **Bray, R. H.** Rapid tests for measuring and differentiating between adsorbed and acid-soluble forms of phosphate in soils. Ill. Agr. Exp. Sta. Mimeographed Pamphlet AG 1028. 1942.
3. **Bray, R. H.**, and **Dickman, S. R.** Tentative fluoride extraction methods for soil phosphorous. Ill. Agr. Exp. Sta. Mimeographed Pamphlet AG 1006. Jan., 1942.
4. **Wynd, F. L.**, and **Noggle, G. R.** Relationships of certain chemical properties of soils near Midland, Douglas County, Kansas, to the accumulation of protein in oat leaves harvested at the jointing stage. Food Res. **10:** 415–425. 1945.
5. **Wynd, F. L.**, and **Noggle, G. R.** Relationships of certain properties of soils near Midland, Douglas County, Kansas, to accumulation of protein in rye leaves harvested at the jointing stage. Food Res. **11:** 127–158. 1946.
6. **Wynd, F. L.**, and **Noggle, G. R.** Relationships between fractions of phosphorus in soil and protein accumulation in leaves of cereals. Food Res. **11:** 351–357. 1946.
7. **Wynd, F. L.**, and **Romig, J. R.** Chemical characteristics of soils in the vicinity of Midland, Douglas County, Kansas. Soil Sci. **56:** 135–142. 1943.

# Chemical Composition of Rye Grown on Different Soil Types in Ontario, Canada

## Part II. Distribution of Nitrogen Fractions in the Plants[1]

F. L. Wynd[2] and G. R. Noggle[3]

### INTRODUCTION

The authors have reported the percentage of nitrogen in the leaves of oats (4) and of rye (5) grown on several types of soils near Midland, Douglas County, Kansas, was related to the group of related soil factors composed of the organic matter, base exchange capacity, and nitrogen. A similar study was reported for the soil factors correlated with the protein in Sudan grass grown in this area (6). A study of the correlation between four fractions of soil phosphorus was also reported (7). They later reported that this same relationship existed for Rosen rye grown on five markedly different types of soils near Wallaceburg, Ontario, Canada (8).

The relationships already reported appear to exist for different species of grasses grown on markedly different types of soil in widely separated areas.

It is of considerable interest to know the relative distribution of the nitrogen fractions in grasses containing different amounts of nitrogen, and grown under divergent nutritional conditions. The application of the conventional factor, 6.25, to the nitrogen content of forage plants in order to estimate the protein content of the material presumes that a more or less constant ratio exists between the concentration of nitrogen and protein at various levels of the nitrogen content.

The writers report the present study of the distribution of the nitrogen fractions in two cuttings of Rosen rye grown on five different types of soils near Wallaceburg, Ontario, with the hope that the data will be of interest to students of animal nutrition, and that the data will have a bearing on a critical evaluation of the authenticity of the conventional "protein factor" for the calculation of the protein concentration in grass.

### MATERIALS AND METHODS

The Rosen rye used for the present study was grown near Wallaceburg, Ontario. They were the same samples used by the authors to relate the percentage of total nitrogen in the crop to the various properties of five types of soils. The crops were harvested at the jointing stage and quickly dried in an Arnold dehydrator. The details of the relationships between the nitrogen content of the crops and the various properties of the soils are presented in the authors' previous paper (8).

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[1]The expenses incurred by the present study were borne in part by a grant from the Cerophyll Laboratories, Inc., Kansas City, Missouri.

[2]Michigan State College, East Lansing, Michigan.

[3]Blandy Experiment Farm, University of Virginia, Boyce, Virginia.

The percentages of total nitrogen and of the nitrogen fractions are presented in tables 1 and 2. The relative amounts of the total nitrogen present in each of the nitrogen fractions are presented in tables 3 and 4. The relationships between the nitrogen fractions and the total nitrogen

TABLE 1. *Nitrogen fractions in the first crop of rye from the five soils, expressed as percentages of the oven-dry matter.*

| SOIL | Total nitrogen | Insoluble nitrogen | Soluble nitrogen | Ammonia nitrogen | Nitrate and nitrite nitrogen | Amide nitrogen | Amino nitrogen | Residual nitrogen |
|---|---|---|---|---|---|---|---|---|
| 1. Clyde Silt Loam........ | 2.15 | 1.76 | 0.39 | 0.083 | 0.007 | 0.072 | 0.083 | 0.152 |
| 2. Muck.................. | 4.41 | 3.42 | 0.99 | 0.110 | 0.235 | 0.129 | 0.180 | 0.571 |
| 3. Berrien Sand........... | 2.11 | 1.83 | 0.28 | 0.074 | 0.018 | 0.069 | 0.084 | 0.053 |
| 4. Thames Clay Loam..... | 2.09 | 1.71 | 0.38 | 0.090 | 0.011 | 0.069 | 0.078 | 0.143 |
| 5. Sandy muck............ | 3.57 | 2.88 | 0.69 | 0.104 | 0.069 | 0.117 | 0.138 | 0.331 |

TABLE 2. *Nitrogen fractions in the second crop of rye from the five soils, expressed as percentages of the oven-dry matter.*

| SOIL | Total nitrogen | Insoluble nitrogen | Soluble nitrogen | Ammonia nitrogen | Nitrate and nitrite nitrogen | Amide nitrogen | Amino nitrogen | Residual nitrogen |
|---|---|---|---|---|---|---|---|---|
| 1. Clyde Silt Loam........ | 2.54 | 2.14 | 0.40 | 0.072 | 0.028 | 0.102 | 0.090 | 0.136 |
| 2. Muck.................. | 3.83 | 3.08 | 0.75 | 0.090 | 0.087 | 0.129 | 0.135 | 0.396 |
| 3. Berrien Sand.......... | 2.20 | 1.70 | 0.50 | 0.077 | 0.003* | 0.096 | 0.114 | 0.213 |
| 4. Thames Clay Loam..... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 5. Sandy Muck............ | 3.41 | 2.84 | 0.57 | 0.068 | 0.047 | 0.105 | 0.108 | 0.289 |

*An abnormally low value, although its omission from the figures does not materially alter the nature of relationship shown.

TABLE 3. *Ratios of the concentrations of total nitrogen to various nitrogen fractions in the first harvest of rye.*

| SOIL | Total N / Insol. N | Total N / Sol. N | Total N / Ammonia N | Total N / $NO_3$ & $NO_2$ N | Total N / Amide N | Total N / Amino N | Total / Res. N |
|---|---|---|---|---|---|---|---|
| 1. Clyde Silt Loam.... | 1.22 | 5.52 | 22.5 | 357.1 | 29.8 | 24.9 | 14.2 |
| 2. Muck.............. | 1.29 | 4.47 | 40.0 | 18.8 | 34.2 | 23.5 | 7.72 |
| 3. Berrien Sand....... | 1.14 | 7.51 | 28.6 | 117.2 | 30.6 | 25.2 | 39.8 |
| 4. Thames Clay Loam. | 1.22 | 5.51 | 23.3 | 190.0 | 30.4 | 26.8 | 14.6 |
| 5. Sandy Muck........ | 1.24 | 5.19 | 35.7 | 51.6 | 30.5 | 25.9 | 10.8 |

are presented graphically in figures 1 to 14 inclusive. The numbers of the points in the figures correspond to the numbers of the soils on which the samples were grown as indicated in the tables. The solid circles indicate the data obtained from the first harvest, and the broken circles indicate the data obtained from the second harvest. The graphical units are those used in the tables.

Total nitrogen was determined as recommended by the A.O.A.C. (1). Salicylic acid and sodium thiosulphate were added to the digestion mixture so that nitrates and nitrites would be included in the determination. The ammonia was distilled into a saturated boric acid solution and then titrated with standard hydrochloric acid.

A hot water extract was used for the determination of total soluble nitrogen and the soluble fractions. One gram of dried plant material was added to 20 milliliters of boiling water in a large test tube and stirred with an electric stirrer for 2 minutes. The tube then was placed

TABLE 4. *Ratios of the concentrations of total nitrogen to various nitrogen fractions in the second harvest of rye.*

| Soil | Total N / Insol. N | Total N / Sol. N | Total N / Ammonia N | Total N / $NO_3$ & $NO_2$ N | Total N / Amide N | Total N / Amino N | Total N / Res. N |
|---|---|---|---|---|---|---|---|
| 1. Clyde Silt Loam.... | 1.19 | 6.35 | 35.3 | 90.6 | 24.9 | 28.3 | 18.6 |
| 2. Muck.............. | 1.24 | 5.20 | 42.6 | 44.0 | 29.7 | 28.3 | 9.66 |
| 3. Berrien Sand....... | 1.29 | 4.40 | 28.6 | 733.3(?) | 23.0 | 21.6 | 10.2 |
| 4. Thames Clay Loam. | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| 5. Sandy Muck........ | 1.20 | 6.00 | 50.2 | 72.5 | 32.6 | 31.6 | 11.8 |

TABLE 5. *Logarithms of certain relationships between the nitrogen fractions in rye grown on 5 types of soils.*

| Soil | $NO_3$ and $NO_2$ Nitrogen | | | | Residual Nitrogen | |
|---|---|---|---|---|---|---|
| | Percentages of N as $NO_3$ and $NO_2$ | | Ratio $\frac{\text{Total N}}{NO_3 \text{ and } NO_2 \text{ N}}$ | | Ratio $\frac{\text{Total N}}{\text{residual N}}$ | |
| | First Crop | Second Crop | First Crop | Second Crop | First Crop | Second Crop |
| 1. Clyde Silt Loam... | 0.8451 | 1.4472 | 2.5527 | 1.9571 | 1.1523 | 1.2695 |
| 2. Muck............. | 2.3711 | 1.9395 | 1.2742 | 1.6434 | 0.8876 | 0.9850 |
| 3. Berrien Sand...... | 1.2553 | 0.4771 | 2.0682 | 2.8651(?) | 1.5999 | 1.0086 |
| 4. Thames Clay Loam | 1.0414 | ....... | 2.2788 | ....... | 1.1644 | ....... |
| 5. Sandy Muck....... | 1.8388 | 1.6721 | 1.7126 | 1.8603 | 1.0334 | 1.0719 |

in a bath of boiling water for 15 minutes. The tube was then centrifuged at 1500 revolutions per minute for 10 minutes. The liquid was next decanted through a paper filter in a Gooch crucible. The above procedure was repeated 4 times until about 100 milliliters of extract were obtained. After cooling, the extract was brought to a volume of 100 milliliters, and aliquots used to determine the soluble nitrogen fractions.

Insoluble nitrogen was determined on the extracted grass remaining in the Gooch crucible prepared as described above. It was convenient to transfer the filter pad with the residue to the Kjeldahl digestion flask.

Ammonia nitrogen was determined by the method described by Schlenker (3) and Hawk and Bergheim (2). An aliquot of 5 milliliters

of the hot water extract treated with Nesslers reagent and the ammonia determined colorimetrically by the Coleman spectrophotometer using a PC-4 filter and a transmission band of 500 millimicrons.

Nitrate nitrogen was determined in aliquots of 5 milliliters of the hot water extract by the procedure of Schlenker (3). A color was developed with phenoldisulfonic acid and the transmission at 410 millimicrons was determined by the Coleman spectrophotometer.

Amide nitrogen was also determined by the method of Schlenker (3). A 5-milliliter aliquot of the protein-free and ammonia-free extract was treated with sulphuric acid and placed in a boiling water bath for 3 hours. The final determination of the released ammonia was carried out by the use of Nesslers reagent as described above.

Amino nitrogen was determined in 5-milliliter aliquots of the protein- and ammonia-free extract as described by Schlenker (3). The liberated ammonia was determined as described above.

Residual nitrogen was determined by the Kjeldahl procedure on the water extract which had been freed of nitrates, nitrites, ammonia, amino and amide nitrogen.

## EXPERIMENTAL RESULTS

The data graphically presented in figure 1 clearly indicate that the percentages of insoluble nitrogen increase as the percentages of total nitrogen increase. This relationship is to be expected since such a large fraction of the total nitrogen is in the form of the insoluble protein. It might be assumed, also, that the concentration of insoluble nitrogen is a constant fraction of the total nitrogen, but the data presented in figure 2 shows that this is not true, for it is evident that the ratio of total nitrogen to insoluble nitrogen markedly increases as the total nitrogen increases. This indicates that the relative amount of insoluble nitrogen decreases as the total nitrogen increases.

The concentration of soluble nitrogen also increases as the concentration of total nitrogen increases, as is evident from the data presented in figure 3. It is evident from the preceeding discussion and from figure 2, that if the relative amount of insoluble nitrogen decreases with increasing amounts of total nitrogen, the relative amounts of soluble nitrogen would correspondingly increase. Figure 4 shows this reciprocal relationship.

Since the soluble nitrogen consists of various types of nitrogen, the problem presents itself as to what fraction or fractions of the soluble nitrogen is responsible for the increasing proportion of the total nitrogen in the soluble form. A study of the ratios of the separate fractions of soluble nitrogen to the total nitrogen permits rather definite conclusions.

Figure 5 presents graphically the relationship of the concentration of ammoniacal nitrogen to the total nitrogen. The points in the figure are scattered because of the comparatively great experimental error in the determination of the small amounts of ammonia in plant tissue, but in general, the percentage of ammoniacal nitrogen increases as the total nitrogen increases. If points 2 and 5 for the first crop and point 2 for the second crop be ignored, there appears to be a rapid decrease of

ammoniacal nitrogen with increasing total nitrogen. However, the relationship of ammoniacal to total nitrogen is more evident in figure 6 which presents the relationship of the ratios of the total to the ammoniacal nitrogen to increasing concentrations of total nitrogen. This figure shows that the relative amounts of ammoniacal nitrogen diminish as the total nitrogen increases.

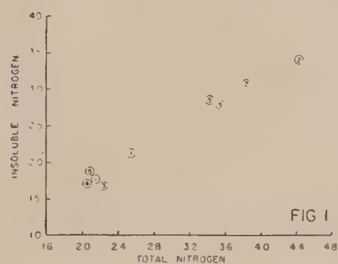

FIG 1

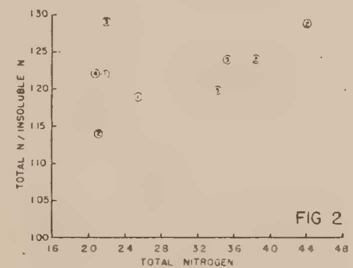

FIG 2

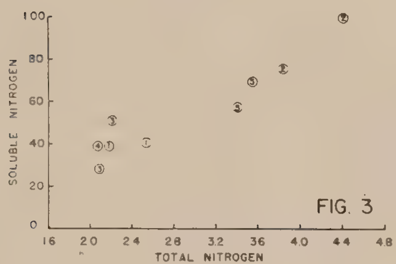

FIG. 3

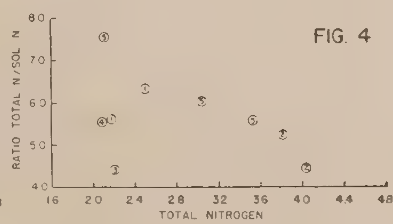

FIG. 4

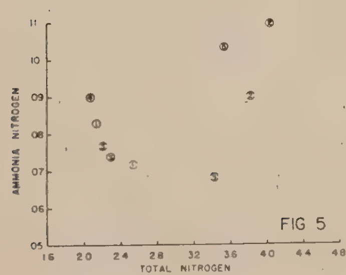

FIG 5

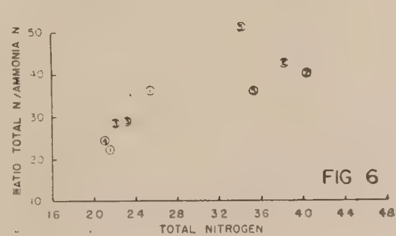

FIG 6

The data presented in figures 7 and 8 are especially interesting. Figure 7 shows that the amount of nitrate and nitrite nitrogen increases as the total nitrogen increases, and figure 8 shows that this increase is logarithmic. The ratios of the total nitrogen to the nitrate and nitrite nitrogen decrease as the total nitrogen increases; and figure 10 indicates that the rate of this increase is also logarithmic. It is evident that the relative amounts of nitrogen, present as nitrate and nitrite become an increasingly greater fraction of the total nitrogen, as the

concentration of the total increases. Figures 7 to 10 show that the actual increase of nitrate and nitrite nitrogen is logarithmic as the total nitrogen increases, and that the relative amount of the total nitrogen in these forms also increases logarithmically with increasingly higher concentrations of total nitrogen.

The concentration of amide nitrogen is shown by figure 11 to increase as the total nitrogen increases, and figure 12 shows that the ratio of the

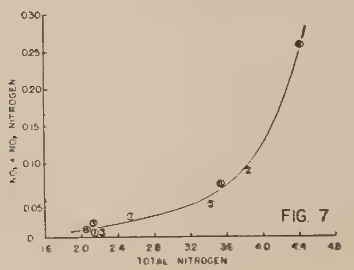


FIG. 7

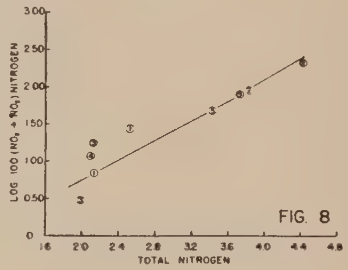


FIG. 8

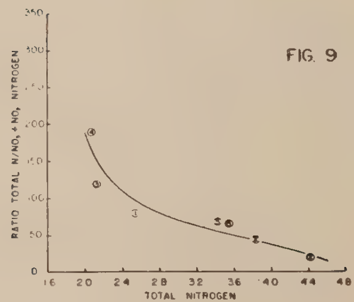


FIG. 9

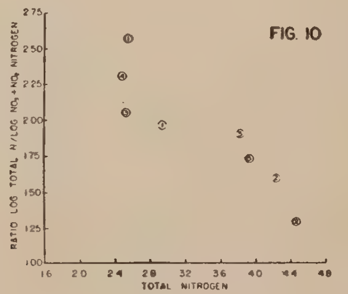


FIG. 10

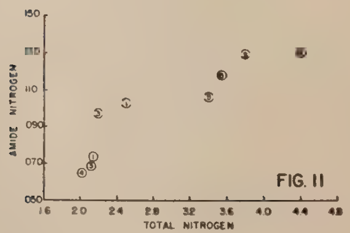


FIG. 11

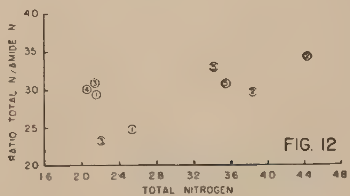


FIG. 12

total to the amide nitrogen also increases with increasing percentages of total nitrogen. These data show that the relative amount of amide nitrogen with respect to the total nitrogen decreases as the total nitrogen increases.

Figure 13 indicates that the concentration of amino nitrogen increases as the concentration of total nitrogen increases. The points in figure 14 are scattered, and no definite trend can be observed for the relationships of the ratios of total nitrogen to amino nitrogen with increasing amounts

of total nitrogen. The amino nitrogen was the only nitrogen fraction studied which did not exhibit a definite trend in its ratio to the total nitrogen.

The data for residual nitrogen are particularly interesting. "Residual" nitrogen is a collective term which refers to all soluble nitrogen except ammoniacal, amido-, amino-, nitrate, and nitrite. It is difficult to define the biochemical significance of this vaguely defined

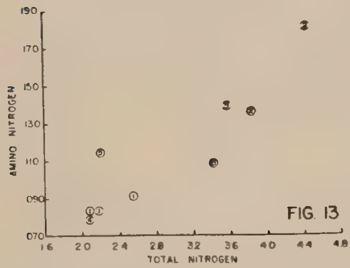

FIG. 13

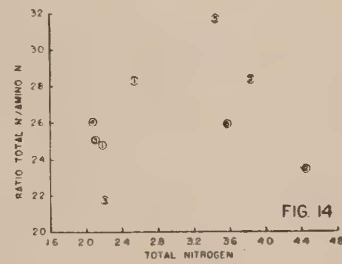

FIG. 14

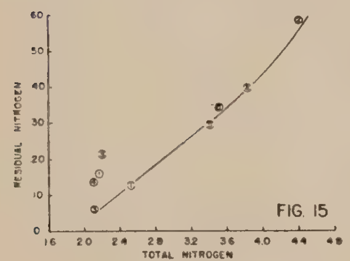

FIG. 15

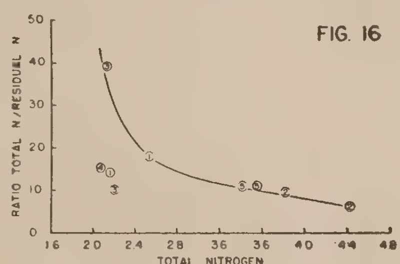

FIG. 16

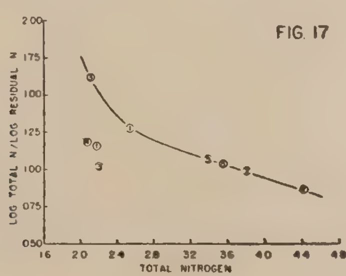

FIG. 17

raction. It may be assumed that it includes soluble nitrogen in cyclic combination, and in complex compounds from which it cannot be liberated by the usual hydrolytic-procedures utilized for the analytic determination of amido- and amino- nitrogen.

Figure 15 shows that the concentration of residual nitrogen increases markedly as the concentration of total nitrogen increases. Figure 16 shows that the ratio of total nitrogen to residual decreases with increasing amounts of total nitrogen. It is apparent, therefore, that the percent-

ages of residual nitrogen relative to the percentages of total nitrogen increase with increasing percentages of total nitrogen. Figure 17 shows that this relative increase with respect to the total is logarithmic, at least at the higher concentrations of total nitrogen.

There was a general agreement between the 2 crops in the relative magnitudes of the concentrations of residual nitrogen. The data in tables 1 and 2 show that the amount of residual nitrogen in the first crop from the sandy soil was abnormally small. This error is not great enough to destroy the general logarithmic slope of the curve in figure 16, although the magnitude of the ratio (point 3, solid circle) actually would be too high. However, the logarithm of this ratio does disturb the logarithmic slope of the curve in figure 17. If the determination of residual nitrogen involved in this ratio be admitted to be too small, then the logarithmic slope of the curve in figure 17 would be restored.

## DISCUSSION

The data presented above show that variations in the percentages of total nitrogen in Rosen rye plants are accompanied by significant changes in the relative amounts of the various nitrogen fractions. For example, the relative amounts of soluble nitrogen increase as the total increases. The abrupt increase of the nitrate and nitrite, and of the residual nitrogen are responsible for the increase in the relative amount of the soluble nitrogen.

The fact that the relative amounts of nitrogen present in various fractions vary with changes in the total nitrogen content of Rosen rye has an important bearing on the nutritional value of the crop, for it is evident that the conventional protein factor of 6.25 can not be applied to the different percentages of nitrogen in the crop in order to calculate the concentration of protein. Even if the nitrate and nitrite nitrogen were eliminated from the total nitrogen, the "crude" protein calculated by the factor 6.25 would not necessarily indicate the value of the crop as a source of protein in the diet of animals.

Additional studies on the interpretation of the calculated protein percentages in grasses will be presented in the near future.

## SUMMARY

1. Rosen rye was grown on five different types of soils, harvested just before the jointing stage and the tissue analyzed for various nitrogen fractions. The fractions determined were total, insoluble, soluble, ammonia, nitrate and nitrite, amide, amino, and residual.

2. The percentages of each fraction were related to the percentages of total nitrogen, and the ratios of the total nitrogen to each fraction were also related to the total nitrogen.

3. The percentages of all fractions increased as the percentage of total nitrogen increased. The concentration of nitrogen in the nitrate and nitrite fractions increased logarithmically as the total nitrogen increased.

4. The ratio of the total nitrogen to the insoluble nitrogen diminished as the total nitrogen increased, while the ratios of the soluble nitrogen to the total increased, which showed that relatively more of

the nitrogen was in the hot water-soluble fraction as the total nitrogen increased.

5. Each of the ratios of ammonia, nitrate, and nitrite, and amide nitrogen to the total increased in magnitude as the total nitrogen increased, which showed that the relative percentages of nitrogen in these fractions diminished as the percentage of total nitrogen increased.

6. The ratio of amino nitrogen to the total exhibited no definite trend as the total nitrogen increased, which showed that the relative amount of nitrogen in the amino form did not vary consistently with increasing amounts of total nitrogen.

7. The ratios of nitrate and nitrite, and of residual nitrogen decreased as the total increased, which showed that the relative amounts of nitrogen present in these fractions increased as the total nitrogen increased. These increases were logarithmic as the total nitrogen increased.

8. The data show that the feeding value of the nitrogen content of Rosen rye varies with different concentrations of total nitrogen. This situation is true, even if the nitrate and nitrite nitrogen be subtracted from the total.

9. The application of the conventional protein factor, 6.25, to the nitrogen content of Rosen rye plants is not an accurate procedure for estimating the protein content of material containing widely different amounts of nitrogen.

## LITERATURE CITED

1. **Association of Official Agricultural Chemists.** Official and tentative methods of analysis. Fourth Ed. Assoc. Official Agri. Chem. Washington, D. C. 1935.
2. **Hawk, P. B.,** and **Bergheim, O.** Practical physiological chemistry. Ed. 11. Blakiston, Philadelphia. 1937.
3. **Schlenker, F. S.** A system of analysis for plant tissue by use of plant juice. Plant Physiol. **18:** 141–150. 1943.
4. **Wynd, F. L.,** and **Noggle, G. R.** Relationships of certain chemical properties of soils near Midland, Douglas County, Kansas, to the accumulation of protein in oat leaves harvested at the jointing stage. Food Res. **10:** 415–425. 1945.
5. **Wynd, F. L.,** and **Noggle, G. R.** Relationships of certain properties of soils near Midland, Douglas County, Kansas, to accumulation of protein in rye leaves harvested at the jointing stage. Food Res. **11:** 127–136. 1946.
6. **Wynd, F. L.,** and **Noggle, G. R.** Effects of selected chemical properties of soils on protein content of Sudan grass. Lloydia **10:** 136–144. 1947.
7. **Wynd, F. L.,** and **Noggle, G. R.** Relationships between phosphorus fractions in the soil and protein accumulation in leaves of cereals. Food Res. **11:** 351–357. 1946.
8. **Wynd, F. L.,** and **Noggle, G. R.** Chemical composition of Rye grown on different soil types in Ontario, Canada. Part I. Nitrogen content of the plants. Lloydia **12**(1): 30–40. 1949.

# Chemical Composition of Rye Grown on Different Soil Types in Ontario, Canada

## Part III. Partition of Soluble Nitrogen in the Plants[1]

F. L. WYND[2] AND G. R. NOGGLE[3]

### INTRODUCTION

The authors have reported previously (1) the relationship between the nitrogen content of rye plants grown on five types of soils in the vicinity of Wallaceburg, Ontario, and also (2) the distribution of the nitrogen fractions at the different levels of total nitrogen in the plants. It was shown that the ratio of the total nitrogen to the hot-water soluble fraction markedly decreased as the concentration of total nitrogen increased, or conversely, that the ratio of the hot-water soluble nitrogen to the total decreased. It was further shown that the inorganic and the "residual" nitrogen were largely responsible for the relatively higher amounts of soluble nitrogen. The varying importance of the soluble fraction of nitrogen for animal nutrition suggests the importance of a more detailed study of the relative changes in the components of this fraction when the total soluble nitrogen is augmented by the nutritional environment of the crop.

### MATERIALS AND METHODS

The materials studied were the same samples of rye which furnished the data for the previous reports. The nature of the samples, the conditions of growth, and the analytical procedures were identical to those previously described.

The data are presented in tables 1 to 3. The numbers of the points in the figures refer to the types of soils listed in the tables which produced the crops. The solid circles indicate data obtained from the first cutting, and the broken circles refer to data from the second cutting. The numerical units used in the figures are the same as those indicated in the tables.

### EXPERIMENTAL RESULTS

*Ammonia nitrogen.*—The data presented in figure 1 show that the percentage of ammonia increased as the total soluble nitrogen increased. It is also apparent that the concentration of ammonia nitrogen was relatively less in the samples from the second cutting at any given total soluble nitrogen content.

When the ratios of the soluble to the ammoniacal nitrogen are graphed against the total soluble, figure 2 shows clearly that the ammoniacal fraction becomes relatively less as the concentration of total soluble

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[1]The expenses incurred by the present study were borne in part by a grant from the Cerophyll Laboratories, Inc., Kansas City, Missouri.

[2]Michigan State College, East Lansing, Michigan.

[3]Blandy Experiment Farm, University of Virginia, Boyce, Virginia.

TABLE 1. *The soluble nitrogen components in two cuttings of rye grown on 5 types of soils, expressed as percentages of oven-dry matter.*

| SOIL | Total sol. nitrogen | | Ammonia nitrogen | | Nitrate and nitrite nitrogen | | Amide nitrogen | | Amino nitrogen | | Residual nitrogen | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd |
| 1. Clyde Silt Loam..... | 0.39 | 0.40 | 0.083 | 0.072 | 0.007 | 0.028 | 0.072 | 0.102 | 0.083 | 0.090 | 0.152 | 0.136 |
| 2. Muck................ | 0.99 | 0.75 | 0.110 | 0.090 | 0.235 | 0.087 | 0.129 | 0.129 | 0.180 | 0.135 | 0.571 | 0.396 |
| 3. Berrien Sand......... | 0.28 | 0.50 | 0.074 | 0.077 | 0.018 | 0.003* | 0.069 | 0.096 | 0.084 | 0.114 | 0.053 | 0.213 |
| 4. Thames Clay Loam. | 0.38 | ...... | 0.090 | ...... | 0.011 | ...... | 0.069 | ...... | 0.078 | ...... | 0.143 | ...... |
| 5. Sandy Muck......... | 0.69 | 0.57 | 0.104 | 0.068 | 0.069 | 0.047 | 0.117 | 0.105 | 0.138 | 0.108 | 0.331 | 0.289 |

* An abnormally low value, probably erroneous.

TABLE 2. *Ratios of the concentrations of total soluble nitrogen to the various components of soluble nitrogen in the first crop.*

| SOIL | Sol. N / Ammonia N | | Sol. N / Amide N | | Sol. N / Amino N | | Sol. N / $NO_3$ & $NO_2$ N | | Sol. N / Res. N | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd | 1st | 2nd |
| 1. Clyde Silt Loam....... | 4.7 | 5.5 | 5.4 | 3.9 | 4.7 | 4.4 | 56.0 | 14.4 | 2.6 | 2.9 |
| 2. Muck.......... | 9.0 | 8.3 | 7.7 | 5.8 | 5.5 | 5.6 | 4.2 | 8.6 | 1.7 | 1.9 |
| 3. Berrien Sand.. | 3.6 | 6.5 | 4.1 | 5.2 | 3.3 | 4.4 | 15.6 | 166.0* | 5.3 | 2.4 |
| 4. Thames Clay Loam....... | 4.2 | ........ | 5.5 | ........ | 4.9 | ........ | 34.6 | ........ | 2.6 | ........ |
| 5. Sandy Muck... | 6.6 | 8.4 | 5.9 | 5.4 | 5.0 | 5.3 | 10.0 | 12.2 | 2.1 | 2.0 |

* An erratic value, probably dependent on the abnormally low value for Nitrate and Nitrite nitrogen.

TABLE 3. *Logarithms of concentrations of certain soluble nitrogen components and their ratios in rye grown on 5 types of soils.*

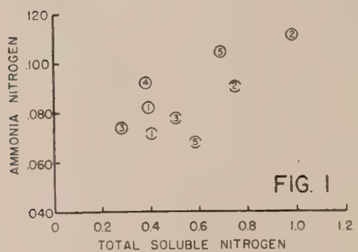
| SOIL | Nitrate and nitrite nitrogen* | | Soluble / $NO_3$ & $NO_2$ | | Soluble / Residual | |
|---|---|---|---|---|---|---|
| | 1st | 2nd | 1st | 2nd | 1st | 2nd |
| 1. Clyde Silt Loam......... | 0.8451 | 0.4472 | 1.7482 | 1.1584 | 0.4150 | 0.4624 |
| 2. Muck..................... | 0.3711 | 0.9395 | 0.6232 | 0.9345 | 0.2304 | 0.2788 |
| 3. Berrien Sand............. | 0.2553 | 0.4771 | 1.1931 | 2.2201 | 0.7243 | 0.3802 |
| 4. Thames Clay Loam...... | 0.0414 | ...... | 1.5391 | ...... | 0.4150 | ...... |
| 5. Sandy Muck............. | 0.8388 | 0.6721 | 1.0000 | 1.0864 | 0.3222 | 0.3010 |

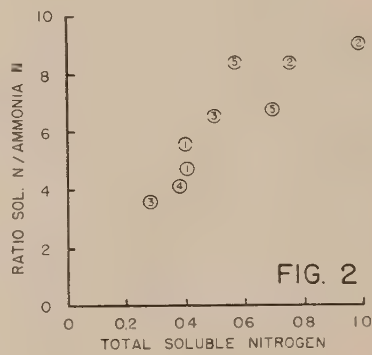
*Concentrations multiplied by $10^3$ to facilitate graphing.

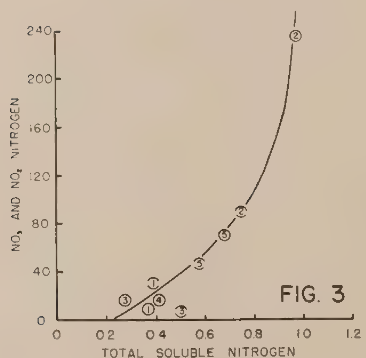
nitrogen increases. As might be expected, however, the ratios obtained from the second harvest are a little greater in magnitude, since the ammonia content of this crop was consistently less than in the first crop.

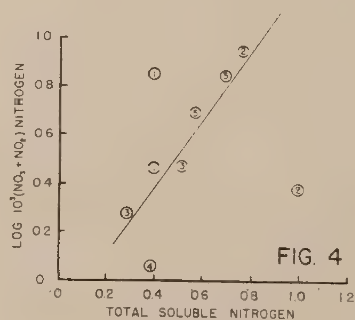
*Nitrate and Nitrite nitrogen.*—The concentration of the nitrate and nitrite fractions increase markedly as the total soluble nitrogen increases.

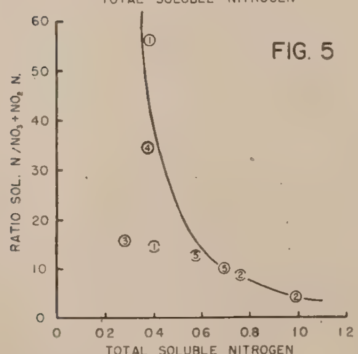
The distribution of the points in figure 3 suggest that this increase is logarithmic. The replotting of the data in figure 4 shows that this is indeed the case. It will be recalled that a similar logarithmic relationship existed (2) when these data were related to the total nitrogen content.



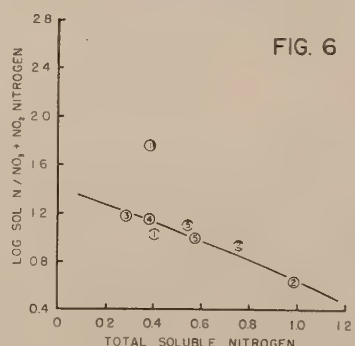




Figure 5 shows that the ratio of total soluble to the nitrate and nitrite nitrogen markedly decreases as the amount of soluble nitrogen increases. Figure 6 suggests that this increase in the relative amount of nitrate and nitrite is logarithmic. A similar situation existed when these data were related to the amount of total nitrogen (2).

*Amide nitrogen.*—The concentration of amide nitrogen is shown by figure 7 to increase as the total soluble nitrogen increases, but the ratios of the soluble to the amide nitrogen presented in figure 8 show that the amide fraction becomes relatively less as the total soluble nitrogen increases.

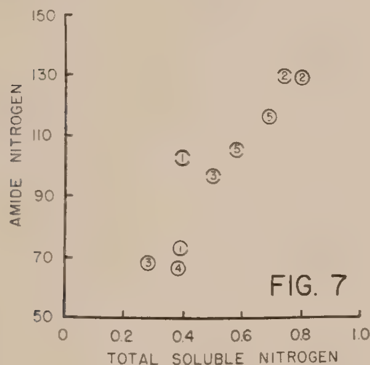


FIG. 7

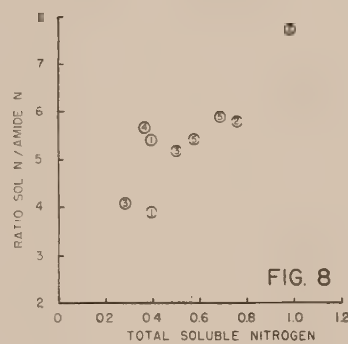


FIG. 8

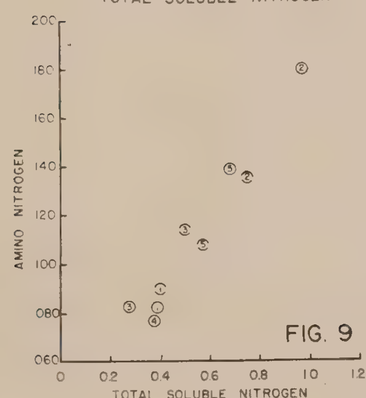


FIG. 9

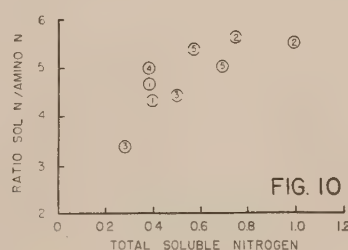


FIG. 10

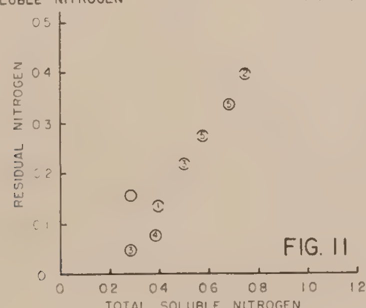
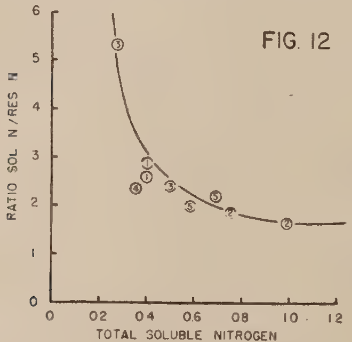


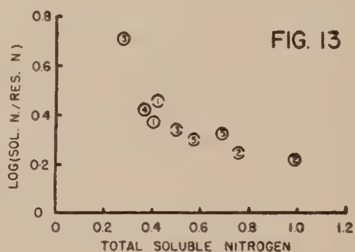
FIG. 11

*Amino nitrogen.*—The percentage of amino nitrogen is shown by figure 9 to increase as the total soluble fraction increases. The greater numerical magnitude of the ratios of soluble to amino nitrogen at the greater concentrations of soluble nitrogen, are apparent from an examina-

tion of figure 10. This situation shows that the relative amount of animo nitrogen becomes less as the total soluble fraction increases.

*Residual nitrogen.*—It is evident from the data presented in figure 11 that the "residual" nitrogen increases very markedly as the total soluble fraction increases. The relationships between the magnitude of the ratios of soluble to residual nitrogen to the total soluble nitrogen are presented in figure 12. There is a very rapid increase in the relative amount of residual nitrogen as the total soluble increases. Figure 13 shows that this rate of increase approaches a logarithmic rate. A similar relationship was observed when the data were related to the total nitrogen concentration (2).




## DISCUSSION

A comparison of all the data presented in the graphs shows that the concentrations of ammoniacal, amido- and amino-nitrogen increase as the concentration of total soluble nitrogen increase, but that the amounts of these components, relative to the total soluble fraction, decrease as the total soluble nitrogen increases.

On the other hand, although the concentration of nitrate and nitrite, and of residual nitrogen also increase as the concentration of total soluble nitrogen increase, these fractions comprise a relatively larger proportion of the total soluble nitrogen as the percentage of the total soluble nitrogen increases. The rates of these increases relative to the total soluble nitrogen were shown to be logarithmic.

When the concentrations of the nitrate and nitrite, and of the residual fractions, are graphed against the concentration of the total soluble nitrogen, it is seen that the relationship is logarithmic for the nitrate and nitrite fraction, and approximately linear for the residual fraction. This difference in the relationship of these two fractions to the total soluble nitrogen shows that the concentration of the nitrate and nitrite fraction increases faster than does the residual component, as the total soluble nitrogen increases.

The residual component of the soluble nitrogen is a vaguely defined complex of nitrogenous compounds. This fraction represents all forms of hot water soluble nitrogenous compounds remaining in the water extract after nitrate, nitrite, ammonia, amide and amino nitrogen have been removed. Residual nitrogen may be defined as organically bound

nitrogen, which is not released as ammonia by the usual mild hydrolytic procedures used for the determination of amino and amide nitrogen. Residual nitrogen, therefore, must be composed of heterocyclic compounds, and of nitrogenous compounds stable to mild hydrolysis.

The uncertainty concerning the nature of the complex mixtures of compounds which are empirically grouped as "residual" nitrogen make this fraction of special interest from the standpoint of the recognized nutritional value of young pasture grasses which are especially rich in "crude protein" or in total nitrogen. Since the soluble nitrogen comprises a relatively greater fraction of the total nitrogen as the concentration of total nitrogen becomes greater, and since the residual nitrogen fraction of the soluble nitrogen increases logarithmically as the soluble nitrogen increases, it is apparent that high-protein grass might vary more profoundly in its nutritional value than mere differences in the percentages of crude protein or in total nitrogen would suggest.

The relative amounts of nitrogen in the nitrate and nitrite fraction also increase logarithmically as the concentration of soluble nitrogen increases. However, within the normal range of variation of the concentration of the nitrate and nitrite fraction, the evaluation of the nutritive value of the grass is not seriously confused, since this fraction is not included in the usual determination of "crude protein." On the other hand, it should be borne in mind constantly when the nutritional evaluation of young pasture grass is attempted, that the forage which contains exceptionally high concentrations of crude protein also may contain high concentrations of nitrate nitrogen.

## SUMMARY

1. Rye grown on five types of soils near Wallaceburg, Ontario, was harvested just before the jointing stage and the concentrations of hot water soluble nitrogen were determined. The components of the soluble nitrogen fraction, nitrate and nitrite, ammonia, amino, amide, and residual nitrogen were also determined.

2. The concentration of each of the soluble components increased as the concentration of total soluble nitrogen increased.

3. The concentrations of ammonia, amide, and amino nitrogen *relative* to that of the total soluble nitrogen *decreased* as the total soluble nitrogen increased.

4. The concentrations of nitrate and nitrite, and of residual nitrogen *relative* to that of the total soluble nitrogen *increased* as the total soluble nitrogen increased. These increases were logarithmic for the nitrate and nitrite fraction, and linear for the residual fraction.

5. The importance of the changes in the relative concentrations of the soluble nitrogen components as the percentage of total soluble nitrogen increases is discussed in relationship to the nutritional evaluation of young grass.

## LITERATURE CITED

1. **Wynd, F. L.,** and **Noggle, G. R.** Chemical composition of rye grown on different soil types in Ontario, Canada. Part I. Nitrogen content of the plants. Lloydia **12**(1): 30–40. 1949.
2. **Wynd, F. L.,** and **Noggle, G. R.** Chemical composition of rye grown on different soil types in Ontario, Canada. Part II. Distribution of nitrogen fractions in the plants. Lloydia **12**(1): 41–49. 1949.

# Florida Lepiotas

William A. Murrill
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Members of this group are fleshy gill-fungi found in various habitats during spells of warm, rainy weather. Most of them are edible, but because of their superficial resemblance to poisonous species of the genus *Amanita* one must use caution in picking them for food. The old genus *Lepiota* is now divided into *Chlorophyllum*, *Limacella* and *Lepiota*, all three treated by the author in North American Flora **10**: 40–65. 1914. A number of new Florida species have been described in recent years, the types of which are to be found in the herbarium of the Florida Agricultural Experiment Station at Gainesville, in the vicinity of which most of the collecting has been done. Further field-work is much to be desired. Unlike most fleshy fungi the Lepiotas dry readily and usually keep their characters well.

KEY TO GENERA

Spores green when mature and fresh.........................1. Chlorophyllum
Spores hyaline.
    Pileus dry.................................................2. Lepiota
    Pileus viscid..............................................3. Limacella

## 1. Chlorophyllum Mass.

Pileus fleshy, dry, squamulose; lamellae free, white, colored green by the ripe spores; annulus persistent, movable; stipe bulbous.

1. *C. molybdites* Mass. (*Lepiota Morgani* Pk.). See N. Am. Fl. **10**: 64. 1914.—Described from Guiana and found in open ground or thin woods from N. J. and Ia. to Fla., Calif. and Texas; also trop. Am. One of the commonest and most conspicuous gill-fungi in Fla., appearing along the highways, in fields and in pastures. It is definitely poisonous. The fruit-bodies often appear in large fairy rings. When young the pileus is covered with a tough isabelline cuticle which breaks up into prominent scales as the cap expands. Many species of Amanita are similar in appearance but in that genus the patches on the cap are not fragments of the cuticle but remains of the ruptured volva carried up and distributed over the surface of the expanding pileus.

## 2. Lepiota P. Browne

Pileus fleshy, dry, usually squamulose or pruinose; lamellae free, rarely varying to adnate; spores hyaline, sometimes tinged with yellow or brown; veil usually forming an annulus; stipe mostly enlarged below.

Pileus usually reaching 2 cm. or less in breadth.
    Pileus some shade of red or pink.
        Stipe 1.5 cm. long..........................................*L. rubriceps*
        Stipe 2.5 cm. long..........................................*L. roseiceps*
        Stipe 3.5–5 cm. long.
            Stipe white.............................................*L. subrepanda*
            Stipe reddish-brown.....................................*L. subrosea*

Pileus fulvous with bay umbo.................................*L. truncatispora*
Pileus isabelline, umbonate; stipe pallid..........................*L. anomala*
Pileus rosy-fulvous, umbonate; stipe white.......................*L. roseifulva*
Pileus murinous to fumose; stipe white to avellaneous...........*L. fumosiceps*
Pileus lemon-yellow; stipe 4 cm. long...........................*L. citriniceps*
Pileus flavous; stipe 8–10 cm. long..........................*L. cretaceiformis*
Pileus white, fibrillose; disk glabrous and isabellinae..........*L. subcristatella*
Pileus white to gray with darker scales and disk.
    Pileus not umbonate.
        Stipe 1–1.5 cm. long................................*L. subphaeosticta*
        Stipe 3–5 cm. long..................................*L. caerulescens*
        Stipe 6–10 cm. long.......................................*L. Westii*
    Pileus umbonate.
        Stipe about 1.5 cm. long.
            Pileus 3 mm. broad...............................*L. subpumila*
            Pileus 10–15 mm. broad...........................*L. subfulvastra*
        Stipe 2–3 cm. long.
            Umbo blackish...................................*L. subcultorum*
            Umbo isabelline...................................*L. gilvidisca*
        Stipe 4–5 cm. long..............................*L. phaeostictiformis*
Pileus usually over 2 cm. broad.
    Pileus not umbonate.
        Pileus usually under 5 cm. broad.
            Pileus glabrous, smooth, white; disk fulvous..........*L. subfulvidisca*
            Pileus with dark-brown conic warts..................*L. asperiformis*
            Pileus squamulose.
                Stipe fuliginous.......................................*L. Venus*
                Stipe rufescent.................................*L. conspurcata*
                Stipe reddish-brown; pileus isabelline............*L. subroseifolia*
                Stipe bay; pileus bay.................................*L. brevipes*
                Stipe white, drying dark-pink...................*L. subrhodopepla*
                Stipe white, unchanging.
                    Pileus cream, disk chestnut......................*L. floridana*
                    Pileus fumose to pallid........................*L. fumosialba*
                    Pileus fulvous....................................*L. pinicola*
                    Pileus testaceous; disk latericious.................*L. aurora*
        Pileus usually over 5 cm. broad.
            Pileus smooth, white; odor unpleasant..............*L. praegraveolens*
            Pileus squamulose; odor pleasant.
                Scales isabelline.................................*L. subrhacodes*
                Scales brown....................................*L. subasperula*
    Pileus usually umbonate.
        Pileus and stipe becoming brown when bruised or on drying..*L. brunnescens*
        Pileus and stipe white or yellow throughout, sulcate, farinose;
          stipe bulbous, 8–16 cm.......................................*L. cretacea*
        Pileus striate to the umbo; stipe 5–7.5 cm.................*L. longistriata*
        Pileus red or purple, smooth or sometimes becoming squamulose;
          stipe 3–9 cm............................................*L. rubrotincta*
        Pileus large, dark-scaly; stipe usually 15–25 cm................*L. procera*
        Pileus not as above.
            Pileus pruinose or pubescent.
                Pileus 2–2.5 cm. broad...............................*L. aeruginea*
                Pileus 3–3.5 cm. broad..............................*L. subneophana*
                Pileus 5–7.5 cm. broad............................*L. mammillata*
            Pileus squamulose.
                Scales pale-ochraceous-isabelline......................*L. Humei*
                Scales pale-chestnut...............................*L. tinctoria*
                Scales fulvous or rufous...........................*L. clypeolaria*
                Scales testaceous..............................*L. cristatiformis*
                Scales umbrinous..............................*L. subdryophila*
                Scales blackish.................................*L. sanguiflua*

ANNOTATED LIST OF SPECIES

*L. aeruginea* Murr. Lloydia **7:** 305. 1944.—Described from Gainesville, in dry oak-pine woods and found in the vicinity under oak, bamboo and hickory.

*L. anomala* Murr. Lloydia **9:** 317. 1946.—Described from Gainesville, on an open grassy lawn.

*L. asperiformis* Murr. Lloydia **6:** 220. 1943.—Described from Gainesville on the ground in woods.

*L. aurora* Murr. Jour. Fla. Acad. Sci. **8:** 178. 1945.—Described from Gainesville, in soil under Japanese shining privet, and found also under longleaf pine.

*L. brevipes* Murr. Jour. Fla. Acad. Sci. **8:** 178. 1945.—Described from Gainesville, on the ground in an open high hammock.

*L. brunnescens* Pk. See N. Am. Fl. **10:** 52. 1914.—Described from St. Louis, Mo., and found in open woods or grassy places from N. Y. and Mo. to Fla. and S. Calif. Common about Gainesville in leaf-mold in oak or mixed woods. In Va. I found it in oak woods.

*L. caerulescens* Pk. See N. Am. Fl. **10:** 52. 1914.—Described from Ohio and found in O., Mo. and Fla. Collected in Alachua Co., Fla., under beech trees and in mixed woods of longleaf pine and oak. Frequent about Gainesville in high hammocks.

*L. cinnabarina* (A. & S.) Karst. *Cystoderma cinnabarinum* (A. & S. *ex* Secr.) Fayod. See Smith and Singer, Papers Mich. Acad. Sci. **30:** 94. 1945. Described from Europe and distributed throughout Eur. and temp. N. A. in both acerose and frondose woods. Rare about Gainesville under shrubs and frondose trees such as laurel oak and camphor. Bresadola's plate of it is said to be a form of *Cystoderma granulosum*.

*L. citriniceps* Murr. Lloydia **9:** 317. 1946.—Described from Gainesville, on the ground in a high hammock.

*L. clypeolaria* (Bull.) Quél. See N. Am. Fl. **10:** 62. 1914. Described from France and found in woods from Me. and Ore. to Fla. and Ala. About Gainesville it is common in oak woods on leaf-mold and rarely on rotten hardwood. Bresadola found it chiefly under conifers; in Va. I collected it in oak woods.

*L. conspurcata* (Willd.) Morgan. See N. Am. Fl. **10:** 56. 1914.—Described from Germany and found in open grounds and woods throughout temp. N. A. Collected in Kelley's Hammock, northwest of Gainesville, in leaf-mold. Bresadola found it in woods or gardens; Kauffman in low woods and often on lawns. It is usually called *L. cristata* (Bolt.) Quél.

*L. cretacea* (Bull.) Morgan. See N. Am. Fl. **10:** 49. 1914.—Described from France and cosmopolitan in rich soil either exposed or lightly shaded. There are two color-forms, white and yellow. About Gainesville it is abundant in flower-beds, trash-piles, pine woods and frondose woods. Also found in Clay and Marion Counties.

*L. cretaceiformis* Murr. Lloydia **7:** 305. 1944.—Described from near Gainesville in dense, low frondose woods and frequent in the vicinity in leaf-mold in moist hammocks.

*L. cristatiformis* Murr. Lloydia **9:** 317. 1946.—Described from Gainesville, in a high hammock, and frequent in the vicinity.

*L. floridana* Murr. Mycol. **33:** 286. 1941.—Described from Gainesville, in rich, exposed, grassy soil, and also collected under an oak and in a high hammock.

*L. fumosialba* Murr. Jour. Fla. Acad. Sci. **8:** 178. 1945.—Described from Gainesville, on an open grassy lawn.

*L. fumosiceps* Murr. Jour. Fla. Acad. Sci. **8:** 179. 1945.—Described from Gainesville, on an open grassy lawn, and also collected in the vicinity under a red maple.

*L. gilvidisca* Murr. Lloydia **9:** 318. 1946.—Described from Gainesville, on a grassy lawn partly shaded by oaks.

*L. Humei* Murr. Lloydia **6:** 220. 1943.—Described from Payne's Prairie, near Gainesville, in exposed dry soil, and also collected commonly in the county on old cow dung, in vegetable gardens, and in oak-pine woods. At Cocoa it grew in a manured flower-bed.

*L. longistriata* Pk. See N. Am. Fl. **10:** 50. 1914.—Described from Ala. and found in gardens, lawns or woods in Fla. and Ala.; also W. I. About Gainesville it is common on lawns and under oaks.

*L. mammillata* Murr. Lloydia **6:** 220. 1943.—Described from Gainesville, in rich exposed soil.

*L. phaeostictiformis* Murr. Not yet published. Described from Prairie Creek Hammock, near Gainesville, on a rotten pine log, and later collected in a low hammock at Gainesville on the same host. Also found at the base of a pine, on the ground under pines, and on a lawn under laurel oak.

*L. pinicola* Murr. Lloydia **9:** 318. 1946.—Described from Gainesville, on a rotten pine log in mixed woods.

*L. praegraveolens* Murr. Bull. Torr. **66:** 153. 1939.—Described from Gainesville, in open grassy soil near a stable.

*L. procera* (Scop.) S. F. Gray. See N. Am. Fl. **10:** 63. 1914.—Described from Carniola and found in open grounds and thin woods from New Eng. and Nebr. to Fla. and Ala. Frequent to fairly common about Gainesville in pine woods, live-oak hammocks, red-oak woods, and waste-places. Also collected in Columbia and Marion Counties. Bresadola found it in fields and rocky woods; Kauffman in open woods, meadows, pastures, etc.

*L. roseiceps* Murr. Lloydia **6:** 221. 1943.—Described from Gainesville, on the ground under a tree. Also collected commonly in the vicinity on a lawn, in an azalea bed, under a camphor tree, and in high hammocks under frondose trees.

*L. roseifulva* Murr. Lloydia **9:** 319. 1946.—Described from Gainesville, on an open lawn.

*L. rubriceps* Murr. Bull. Torr. **66:** 153. 1939.—Described from Planera Hammock, northwest of Gainesville, in soil under hardwoods, and collected frequently in the vicinity in high hammocks, being quite common during the summer of 1943.

*L. rubrotincta* Pk. See N. Am. Fl. **10:** 56. 1914.—Described from N. Y. and found in thin woods or wood borders from New Eng. and Nebr. to the Gulf of Mexico. About Gainesville it is rare in high hammocks, and found at times on shaded lawns. Kauffman reported it from frondose or mixed woods in Mich.

*L. sanguiflua* Murr. Jour. Fla. Acad. Sci. **8:** 179. 1945.—Described

from Gainesville, in rich soil under a live-oak. The stipe exudes an orange juice when cut.

*L. subasperula* Murr. Jour. Fla. Acad. Sci. **8**: 179. 1945.—Described from Gainesville, in soil under shrubs, and common in the vicinity on leaf-mold in frondose woods. Also found on rotten oak logs in woods.

*L. subcristatella* Murr. Bull. Torr. **66**: 154. 1939.—Described from Planera Hammock, northwest of Gainesville, on the ground under hardwoods. Found sparingly in the county under hardwoods.

*L. subcultorum* Murr. Lloydia **5**: 139. 1942.—Described from Gainesville, in bare ground near a hedge.

*L. subdryophila* Murr. Bull. Torr. **66**: 154. 1939.—Described from Planera Hammock, northwest of Gainesville, on a rotten hardwood log, and collected on an oak log at Gulf Hammock, Levy Co.

*L. subfulvastra* Murr. Mycol. **33**: 438. 1941.—Described from Gainesville, on an exposed bank. Collected also in the vicinity in shaded soil, under a hedge, and under frondose trees.

*L. subfulvidisca* Murr. Lloydia **6**: 221. 1943.—Described from Gainesville, where it was collected nine times on lawns and three times under oaks. Also found once under pine. Resembles a small *L. mammillata*.

*L. subneophana* Murr. Lloydia **6**: 221. 1943.—Described from Gainesville, under a tung-oil tree, and found also in mixed woods.

*L. subphaeosticta* Murr. Lloydia **6**: 222. 1943.—Described from Gainesville, on a rotten hardwood log in woods.

*L. subpumila* Murr. Lloydia **5**: 139. 1942.—Described from Gainesville, in leaf-mold under an oak.

*L. subrepanda* Murr. Lloydia **6**: 222. 1943.—Described from Gainesville, on dead twigs and humus in oak woods. Frequent in the vicinity under oaks.

*L. subrhacodes* Murr. Lloydia **6**: 223. 1943.—Described from Hunter's Station, near Gainesville, under oaks in a high hammock, and collected several times in the county under oaks. The caps are sometimes 15 cm. broad.

*L. subrhodopepla* Murr. Mycol. **33**: 438. 1941.—Described from Gainesville, where it was six times collected on lawns and as often under hardwoods, such as oaks, laurel cherry, etc.

*L. subrosea* Murr. Lloydia **9**: 319. 1946.—Described from Gainesville, in grass under frondose trees.

*L. subroseifolia* Murr. Lloydia **9**: 319. 1946.—Described from Gainesville, in soil under a palm.

*L. tinctoria* Murr. Lloydia **6**: 223. 1943.—Described from Gainesville, on a lawn near frondose trees. Locally abundant.

*L. truncatispora* Murr. Mitchell **55**: 369. 1939.—Described from Newnan's Lake, near Gainesville, on the ground in mixed woods.

*L. truncicola* Murr. Lloydia **6**: 224. 1943.—Described from Gainesville, on an oak log in woods. Not distinct from *L subdryophila.*

*L. Venus* Murr. Jour. Fla. Acad. Sci. **8**: 180. 1945. Described from Gainesville, in leaf-mold under a laurel oak. Very rare.

*L. Westii* Murr. Lloydia **6**: 224. 1943.—Described from Gainesville, on the ground in oak woods. Also collected in the vicinity in mixed woods.

### ADDED SPECIES

**Lepiota australis** (Smith & Singer) Murr. comb. nov.

*Cystoderma australe* Smith & Singer, Papers Mich. Acad. Sci. **30**: 97. 1945. Described from Matheson Hammock, Dade Co., on a decaying log.

## 3. LIMACELLA Earle

Pileus fleshy, distinctly viscid; lamellae free; spores hyaline; veil usually forming an annulus; stipe central, slender.

Hymenophore white .......... *L. illinita*
Hymenophore brown .......... *L. glischra*

*L. glischra* (Morg.) Murr. N. Am. Fl. **10**: 41. 1914.—Described from O. and found in rich soil in woods in O., Tenn., Mich. and Fla. Very rare at Gainesville in frondose woods. Kauffman found it in birch, maple and hemlock woods.

*L. illinita* (Fr.) Murr. N. Am. Fl. **10**: 40. 1914.—Described from Sweden and found in grassy woods and fields in the U. S., southward to Fla. Common about Gainesville on lawns and in thin oak woods. Bresadola reported it from weedy places in coniferous woods; while Kauffman found it in birch, elm and maple woods. I sometimes find it in fairy rings.

### LEPIOTA IN MICHIGAN AND FLORIDA

A comparison of the fruiting season of certain species occurring in both states. The Michigan records were made by Dr. Kauffman, those of Florida by myself.

| Species | Michigan | Florida |
|---|---|---|
| *clypeolaria* | July–October | July 20–November 9 |
| *conspurcata* | July–October | July 19 |
| *cretacea* | June–September | May 27–October 20 |
| *illinita* | September | June 1–November 12 |
| *procera* | August–October | November 10–December 16 |
| *rubrotincta* | August–September | July 1–October 21 |

# Florida Tricholomas

William A. Murrill

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Species of this group were treated by the author in North American Flora **10:** 3–35. 1914. Since *Tricholoma* was preoccupied, *Melanoleuca* Pat. had to be used for the larger division, with *Cortinellus* Roze for the smaller one. All of the author's recent species have been described also as Tricholomas, for the benefit of those using Saccardo's nomenclature.

The mushrooms here treated are fleshy, dry or viscid; their gills are usually sinuate or adnexed and the spores are hyaline, while the stipe is central, mostly stout, and a veil is absent. *Cortinellus* differs from *Melanoleuca* in the *conspicuous* decoration of fibrils or scales on the surface of the pileus. Many of its members, also, are found on dead wood.

The author's older collections are at the N. Y. Botanical Garden but his recent Florida specimens are in the herbarium of the Florida Agricultural Experiment Station.

### KEY TO CORTINELLUS SPECIES

| | |
|---|---|
| Growing in humus or sawdust. | |
| Pileus gray or grayish-brown | *C. multiformis* |
| Pileus, gills and stipe livid | *C. totilividus* |
| Pileus some shade of red or reddish-brown. | |
| Odor strong, disagreeable | *C. formosus* |
| Odor farinaceous | *C. azalearum* |
| Odor none, but bitter | *C. imbricatus felleus* |
| Growing on decayed wood. | |
| Pileus melleous, disk fuliginous | *C decorus* |
| Pileus fulvous | *C. subdecorosus* |
| Pileus red or purple, sometimes yellowish with age | *C. rutilans* |
| Pileus umbrinous | *C. quercicola* |

### ANNOTATED LIST OF SPECIES

*C. azalearum* Murr. Lloydia **5:** 137. 1942.—Described from Gainesville, in an azalea bed.

*C. decorus* (Fr.) Karst. See N. Am. Fl. **10:** 33. 1914.—Described from Sweden and found on decaying trunks of conifers in temp. N. A. About Gainesville it is rather common on pine logs and stumps in pine woods.

*C. formosus* Murr. Mitchell **55:** 370. 1939.—Described from Cary Memorial Forest, Alachua Co., Fla., in pine sawdust by a pond. Also collected in humus and on pine stumps in Columbia and Marion Counties.

*C. imbricatus felleus* Murr. Jour. Fla. Acad. Sci. **8:** 176. 1945.—Described from Gainesville, in pine woods. Rare. Formerly referred by me to *C. vaccinus* (Schaeff.) Roze.

*C. multiformis* (Schaeff.) Murr. See N. Am. Fl. **10:** 34. 1914.—Described from Bavaria and found on the ground in woods throughout temperate regions. About Gainesville it is common in dry pine or oak

woods. Bresadola found it in bushy fields; Kauffman in grassy places in frondose woods. Its usual name is *Tricholoma terreum*.

*C. quercicola* Murr. See description at the end of this paper. Described from Gainesville, on oak.

*C. rutilans* (Schaeff.) Karst. See N. Am. Fl. **10:** 33. 1914.—Described from Bavaria and found on or about old stumps in coniferous or mixed woods. Rare about Gainesville on pine logs. Also collected at St. Augustine. Bresadola found it on dead coniferous trunks; Kauffman on dead wood of pine, balsam and hemlock.

*C. subdecorosus* Murr. Mycol. **35:** 424. 1943.—Described from Sugarfoot, near Gainesville, on a hardwood log in low woods. Also collected in Marion Co., on humus in a low hammock.

*C. totilividus* Murr. Mycol. **35:** 424. 1943.—Described from Juniper Springs, Marion Co., Fla., in moist humus in a low hammock.

KEY TO MELANOLEUCA SPECIES

Pileus distinctly viscid.
- Stipe viscid.................................................*M. alachuana*
- Stipe not viscid.
  - Pileus white or part cream, 4.5 cm. broad.................*M. silvaticoides*
  - Pileus white, up to 10 cm. broad.
    - Odor earthy, unpleasant.................................*M. peralba*
    - Odor pleasant........................................*M. resplendens*
  - Pileus avellaneous, becoming black......................*M. hygrophorus*
  - Pileus dark-gray.................................*M. subcylindrispora*

Pileus dry or only slightly viscid.
- Pileus entirely white.
  - Stipe 2-3 cm. long.
    - Pileus about 3 cm. broad...............................*M. virginea*
    - Pileus 5–7 cm. broad...................................*M. subacris*
  - Stipe 5 cm.; pileus 6 cm.................................*M. calceifolia*
  - Stipe 8 cm.; pileus 4–5 cm..............................*M. subsilvatica*
- Pileus white with rusty spots.................................*M. maculata*
- Pileus whitish or pale-gray, innate-fibrillose, acrid...................*M. acris*
- Pileus white or pallid, disk colored.
  - Disk cream; context bitter-farinaceous.............*M. albissima floridana*
  - Disk fulvous; context farinaceous..........................*M. fulvidisca*
  - Disk fuliginous; context at length bitter..................*M. praebulbosa*
  - Disk reddish-brown; context mild......................*M. ferruginescens*
- Pileus entirely cremous, acrid.................................*M. Westiana*
- Pileus cream and pale-sulphur, disk rosy-isabelline...........*M. subfulvidisca*
- Pileus griseous; context mild.................................*M. piperatiformis*
- Pileus isabelline, mild; stipe glabrous, cremeous..................*M. floridana*
- Pileus pallid to isabelline, with strong earthy odor..............*M. malodora*
- Pileus white with a bluish tint, 1.5–2 cm........................*M. margarita*
- Pileus pale-rosy-isabelline; stipe lemon-yellow..................*M. citrinifolia*
- Pileus avellaneous, glabrous.....................................*M. subvolkertii*
- Pileus pale-avellaneous, finely hispid.......................*M. platyphylloides*
- Pileus avellaneous, subtomentose..........................*M. microsperma*
- Pileus pale-yellow with a reddish tint...........................*M. equestris*
- Pileus pink or red, 7.5–12.5 cm..................................*M. russula*
- Pileus purple-violet, 2.5 cm..............................*M. pseudosordida*
- Pileus pallid or yellowish to olive or smoky-brown, with innate dark fibrils.........................................................*M. sejuncta*
- Pileus fulvous, 9 cm. broad, glabrous........................*M. lasciviformis*
- Pileus pale-gray to murinous, large, bitter......................*M. Watsonii*
- Pileus pale-umbrinous, isabelline when dry, 2–3 cm.; stipe reddish-brown..........................................................*M. adusta*
- Pileus umbrinous to dark-avellaneous; stipe avellaneous....*M. melaleuciformis*

Pileus umbrinous, 4–5 cm.
Stipe pallid. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *M. entoloma*
Stipe umbrinous. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *M. subterreiformis*
Pileus fulginous to fawn, umbonate, mild. . . . . . . . . . . . . . . . . . . . . . *M. melaleuca*
Pileus fuliginous, not umbonate. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *M. australis*
Pileus brown, red-brown or tawny-red; stipe white with red stains, 7.5–10 cm. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . *M. ustaliformis*

ANNOTATED LIST OF SPECIES

*M. acris* (Pk.) Murr. See N. Am. Fl. **10:** 8. 1914.—Described from Mass. and found in thin frondose woods from New Eng. to Fla. and westward to the Rockies. About Gainesville it is frequent under evergreen oaks. Kauffman found it mostly under oak and maple.

*M. adusta* Murr. Mitchell **55:** 370. 1939.—Described from Cary Memorial Forest, Alachua Co., Fla., under gallberry bushes by a lake.

*M. alachuana* Murr. Mycol. **30:** 365. 1938.—Described from Gainesville, on a lawn partly shaded, and also collected a few times under live-oaks in the vicinity. Spores subglobose, 2.5–3 $\mu$.

*M. albissima floridana* Murr. Bull. Torr. **67:** 147. 1940.—Described from Sugarfoot, near Gainesville, under hardwoods in a hammock. Also collected in Planera Hammock. The typical form was described from N. Y. by Peck.

*M. australis* Murr. Lloydia **7:** 306. 1944.—Described from Gainesville, under a laurel oak in woods, and also found near a live-oak in a yard.

*M. calceifolia* Murr. Lloydia **8:** 275. 1945.—Described from Gainesville, in leaf-mold under a laurel oak, and frequent in the vicinity under the same host.

*M. citrinifolia* Murr. Mycol. **30:** 365. 1938.—Described from Gainesville, on the ground in woods, and collected twice under laurel oak.

*M. entoloma* Murr. Lloydia **5:** 140. 1942.—Described from Planera Hammock, northwest of Gainesville, in leaf-mold under hardwoods, and frequent in the county in open mixed woods. *M. subrimosa* Murr. is not distinct.

*M. equestris* (L.) Murr. See N. Am. Fl. **10:** 24. 1914.—Described from Sweden and found under conifers from Can. to Fla. and westward to Calif. About Gainesville it is abundant sometimes under loblolly pines. Bresadola found it in both coniferous and frondose woods; Kauffman among, or under, leaves in both acerose and frondose woods.

*M. ferruginescens* Murr. Lloydia **7:** 306. 1944.—Described from near Gainesville, under a live-oak. Near *T. saponaceum* but distinct.

*M. floridana* Murr. Lloydia **7:** 306. 1944.—Described from Sanchez Hammock, northwest of Gainesville, in rich soil.

*M. fulvidisca* Murr. Lloydia **7:** 307. 1944.—Described from southwest of Gainesville, on the ground in mixed woods.

*M. hygrophorus* Murr. Lloydia **7:** 307. 1944.—Described from Planera Hammock, northwest of Gainesville, on the ground. cf. *Hydrocybe*, near *H. lurida*.

*M. lasciviformis* Murr. Lloydia **8:** 275. 1945.—Described from Gainesville, on leaf-mold in a high hammock.

*M. maculata* Murr. Bull. Torr. **67:** 147. 1940.—Described from

Sugarfoot, near Gainesville, on a rotten pine log in moist woods. Rare. It may belong in *Gymopus*.

*M. malodora* Murr. Lloydia **5:** 141. 1942.—Described from near Gainesville, under live-oaks.

*M. margarita* Murr. Bull. Torr. **67:** 279. 1940.—Described from Gainesville, under hardwoods near Hogtown Creek.

*M. melaleuca* (Pers.) Pat. See N. Am. Fl. **10:** 7. 1914.—Described from Europe and found in fields, lawns and open woods throughout temperate regions. About Gainesville it is common on lawns. Also collected in Columbia, Levy and Marion Counties. Bresadola found it in pastures, weedy places and on the edges of woods; Kauffman rarely in woods but commonly in gardens, cultivated fields, lawns, etc. In northern and central Fla. I collected it mostly on open or partly shaded lawns but also in open dry oak-pine woods and on the margin of southern red-oak woods. The tree hosts did not appear to be an important factor. See description of a cespitose variety at the end of this paper.

*M. melaleuciformis* Murr. Lloydia **8:** 275. 1945.—Described from Cary Forest, east of Gainesville, in a dried-up cypress pond, and also collected on a sandy roadside nearby.

*M. microsperma* Murr. Lloydia **8:** 276. 1945.—Described from Gainesville, on an open grassy lawn near water oaks.

*M. peralba* Murr. Lloydia **5:** 141. 1942.—Described from near Gainesville, in leaf-mold in a high hammock. Related to *T. spermaticum*.

*M. piperatiformis* Murr. Lloydia **9:** 322. 1946.—Described from northwest of Gainesville, in southern red-oak woods. Singer says it is *Lyophyllum australe*, but I disagree. Also found at Bronson, in Levy Co., in dry woods of pine and turkey oak.

*M. platyphylloides* Murr. Lloydia **7:** 308. 1944.—Described from Planera Hammock, northwest of Gainesville, in leaf-mold. Also collected in Kelley's Hammock nearby. Not *Gymnopus platyphyllus*.

*M. praebulbosa* Murr. Lloydia **5:** 141. 1942. Described from Gainesville, in leaf-mold under laurel oaks.

**M. pseudosordida** (Sing.) Murr. comb. nov. *Tricholoma pseudosordidum* Sing. Mycol. **37:** 434. 1945.—Described from near Miami, on the ground among leaves in a hammock.

*M. resplendens* (Fr.) Murr. See N. Am. Fl. **10:** 21. 1914.—Described from Sweden and found in woods in the eastern U. S. Collected once at Gainesville, in leaf-mold under a laurel oak. Kauffman found it in both coniferous and frondose woods.

*M. russula* (Scop.) Murr. See N. Am. Fl. **10:** 22. 1914.—Described from Carniola and found on the ground under oaks or in mixed woods in the E. U. S. About Gainesville it is rather common under live-oaks. Placed by some mycologists in *Hygrophorus*. Bresadola collected it in frondose groves; Shear in oak or mixed woods in Md.

*M. sejuncta* (Sow.) Murr. See N. Am. Fl. **10:** 25. 1914.—Described from England and found in mixed woods in the E. U. S. About Gainesville it is frequent in both pine and dry oak woods; sometimes abundant. At Keystone Heights I collected it under live-oak; at River Rise in a high hammock. Kauffman found it in oak and maple woods.

*M. silvaticoides* Murr. Jour. Fla. Acad. Sci. **8:** 177. 1945.—Described from Gainesville, in laurel-oak woods.

*M. subacris* Murr. Lloydia **5:** 142. 1942.—Described from Gainesville, in leaf-mold under laurel oaks. Also collected in Clay and Putnam Counties under live-oaks. Very near *M. acris* (Pk.) Murr.

*M. subcylindrispora* Murr. Jour. Fla. Acad. Sci. **8:** 177. 1945.—Described from Gainesville, in laurel-oak woods.

*M. subfulvidisca* Murr. See description later in this paper.

*M. subsilvatica* Murr. See description at end of this paper. Described from Planera Hammock, northwest of Gainesville, on the ground. Not *Gymnopus leucocephaloides.*

*M. subterreiformis* Murr. Proc. Fla. Acad. Sci. **7:** 110. 1944.—Described from Gainesville, in low frondose woods.

*M. subvolkertii* Murr. Jour. Fla. Acad. Sci. **8:** 177. 1945.—Described from northwest of High Springs, under scrub oaks by the river in Columbia Co.

*M. ustaliformis* Murr. Lloydia **7:** 307. 1944.—Described from Gainesville, under turkey oak, and frequent in woods in the vicinity. Also in Putnam Co. Formerly referred by me to *M. transmutans* (Pk.) Murr. Laurel oak is the common host about Gainesville, but occasionally loblolly or longleaf pine. At River Rise it was found in a high hammock. Kauffman found the true *transmutans* in frondose woods, sometimes forming mycorrhiza on the roots of black oak.

*M. virginea* Murr. Lloydia **5:** 143. 1942.—Described from Gainesville, in leaf-mold under laurel oaks. Frequent. Also collected in Marion and Putnam Counties. Near Gainesville I found it under live-oak and also in a live-oak hammock. Just below Leesburg a good collection was obtained under live-oaks in a low hammock.

*M. Watsonii* Murr. Proc. Fla. Acad. Sci. **7:** 111. 1944.—Described from Melrose, Alachua Co., Fla., in low ground under live-oaks. Suggesting *T. sudum* but distinct.

*M. Westiana* Murr. Bull. Torr. **67:** 147. 1940.—Described from near Gainesville, on the ground under hardwoods.

## NEW FLORIDA SPECIES

### **Cortinellus quercicola** sp. nov.

Pileo convexo-subexpanso, umbonato, 7–12 cm. lato, striato, fibrilloso, umbrino, grato; lamellis distantibus, latis, albis; sporis ovoideis, $8 \times 5\ \mu$; stipite albo, glabro, $4–7 \times 0.7–2$ cm.

Pileus irregular, convex to subexpanded, umbonate, solitary to subcespitose, 7–12 cm. broad; surface dry, cracking radially, long-striate, distinctly fibrillose, smooth and glabrous on the submammillate, dark-fuliginous umbo, rest of surface umbrinous, not shining, margin thin, irregular, with large lobes at times; context very thin, white, unchanging, mild and pleasant; lamellae ventricose, distant, sinuate, 1–2.5 cm. broad, inserted, thin, entire, white, unchanging; spores ovoid, smooth, hyaline, about $8 \times 5\ \mu$; cystidia none; stipe twisted, enlarged above, smooth, glabrous, shining, white, unchanging, hollow, with a tough, flexible rind, $4–6 \times 0.7–2$ cm.

Type collected by W. A. Murrill on the diseased base of a living laurel oak in Gainesville, Fla., July 18, 1948 (*F* 40833). Also collected by me in a hammock grove at Seven-mile Church, west of Gainesville,

June 18, 1944 (*F* 21797). Suggesting *Collybia platyphylla* but having a much shorter stem and different spores. In Saccardo's nomenclature this would be **Tricholoma quercicola** (Murr.) Murr.

### **Melanoleuca melaleuca** (Pers.) Pat.

### var. **caespitosa** Murr. var. nov.

Pilei caespitosi, ad marginem silvarum.

Pilei fawn-colored, slightly fragrant, sweet and nutty, cespitose; spores subellipsoid, hyaline, uniguttulate, distinctly aculeolate, about 8 × 5–6 μ.

Type collected by W. A. Murrill in rich soil under a southern red oak at the edge of a high hammock in Gainesville, Fla., Aug. 6, 1939 (*F* 19927). There were several dozen hymenophores, all in clusters. In Saccardo's nomenclature this would be *Tricholoma melaleucum* **caespitosum.** (Murr.) Murr. (Syn. /

### **Melanoleuca subfulvidisca** sp. nov.

Pileo convexo, 6.5 cm. lato, glabro, cremeo-sulphureo, farinaceo nauseoque; lamellis latis, subsulphureis; sporis elongatis, ellipsoideis vel ovoideis, levibus, 7–8 × 4–4.5 μ; stipite subaequali, solido, pallido, glabro, 3 × 1–1.5 cm.

Pileus convex, not fully expanding, gregarious, 6.5 cm. broad; surface dry, smooth, glabrous, cream and pale-sulphur with rosy-isabelline disk, margin thin, even, entire, pallid; context white, unchanging, 1 cm. thick, taste very farinaceous, odor penetrating, musty, unpleasant; lamellae sinuate, medium distant, inserted, slightly ventricose, entire, pale-sulphur, 7–9 mm. broad; spores oblong-ellipsoid or pip-shaped, smooth, hyaline, guttulate, 7–8 × 4–4.5 μ; stipe subequal, solid, pallid inside and outside, unchanging, smooth, glabrous, 3 × 1–1.5 cm.

Type collected by W. A. Murrill in rich black soil under laurel oaks in Gainesville, Fla., Dec. 24, 1948 (*F* 40825). Very rare, with a disagreeable odor for which there is no descriptive term. Readily distinguished from *M. fulvidisca* by its color. In Saccardo's nomenclature this would be **Tricholoma subfulvidiscum.**

### **Melanoleuca subsilvatica** sp. nov.

Pileo convexo, 4.5 cm. lato, albo, farinaceo; lamellis distantibus, albis; sporis ellipsoideis, 5 × 3 μ; stipite albo, 8 × 0.6–1.2 cm.

Pileus convex, solitary, 4.5 cm. broad; surface dry, white, not shining, smooth, glabrous, margin even, irregular and slightly lobed; context white, unchanging, odor and taste strongly farinaceous; lamellae sinuate, inserted, distant, medium broad, entire, white, unchanging; spores ellipsoid, smooth, hyaline, about 5 × 3 μ; stipe tapering upward, crooked, smooth, glabrous, slightly pruinose at the apex, white, 8 × 0.6–1.2 cm.

Type collected by West, Arnold and Murrill on the ground in Planera Hammock, July 21, 1938 (*F* 17918). White throughout, with farinaceous odor and taste, and not at all viscid. In the dried state the

disk and stem are pale-umbrinous. Closely related to *M. leucocephaloides* (Pk.) Murr. but distinct. In Saccardo's nomenclature this would be **Tricholoma subsilvaticum.**

COLLECTING IN DECEMBER, 1948

The autumn was dry in Gainesville, with little collecting and not much encouragement for the growth of mycelium in soil or humus. Showers on Dec. 2 brought out a few hymenophores of *Amanitopsis vaginata*, *Galera crispa*, *Russula pectinata*, *R. subalbidula* and *R. Mariae*. A gentle rain on Dec. 8 developed *Boletus biporus*, *Lactarius hygrophoroides*, *Hypholoma fasciculare*, *Lepiota subasperula*, and three common species of *Cortinarius*.

Dec. 9–Dec. 10.—A good rain on Dec. 9 brought out a number of fleshy fungi, most of them common and scarce. *Boletus brevipes* made its first appearance for nearly a year. Other species were: *Boletus bicolor*, *B. roseialbus*, *B. subvelutipes*, *Amanitopsis vaginata*, yellow form, *Lactarius hygrophoroides*, *Russula cyanoxantha*, *R. foetens*, *R. pectinata*, *R. pectinatoides*, *R. subalbidula*, a white Cortinarius and *Clitocybe subilludens*. The last was represented by 4 fruit-bodies at the base of the palm where the type collection was made.

Dec. 11–Dec. 17.—The weather was like spring; warm, fair, dry, with little or no wind. Bright moonlight nights completed the picture. Only in moist, shady situations did fungi appear, and these were scarce. I found *Lactarius hygrophoroides*, *Russula pectinata*, *Cortinarius equestriformis*, *Boletus luteus* var. *cothurnatus* and five specimens of *B. brevipes*. The two last, of course, were under pines. A few common red Russulas were also seen.

Dec. 18–Dec. 19.—A shower on Dec. 18 followed by a heavy rain on Dec. 19, with continued mild weather, brought out a number of fleshy fungi. There was a mixture of fall and winter species with certain heat-loving species lacking, which indicated that both habit and weather were exerting their influence. Species collected were: *Claudopus nidulans*, *Scleroderma flavidum*, *Galera crispa*, *Amanita verna*, *Tricholoma melaleucum*, *Limacella illinita*, *Russula foetens*, *R. pectinata*, *Lactarius lactifluus*, *L. luteolus* and *L. paradoxus*.

Dec. 20.—It was clear at 1 a. m. but by 7 a. m. a northwest wind brought clouds, a trace of rain and increased cold. *Lactarius paradoxus* appeared in quantity, some fruit-bodies very large; also *Boletus brevipes*, *B. luteus* var. *cothurnatus*, *B. bicolor*, *B. subvelutipes*, *B. praeanisatus*, *Clitopilus prunulus*, *Cortinarius equestriformis*, and *Clitocybe subilludens* in quantity at the type locality and also at the base of a laurel oak.

Dec. 21–Dec. 22.—Fair and cool, mild in afternoons. Fungi observed: *Lactarius paradoxus*, *Gomphidius alachuanus*, *Boletus subvelutipes*, *Russula cyanoxantha* and a common white Cortinarius.

Dec. 23.—Warm, slightly cloudy to clearing. Collected *Boletus subvelutipes*, *Russula pectinata*, a large purple Russula, purple Cortinarius and the common white species.

Dec. 24.—Fair to cloudy, mild, with a northeast breeze. *Lactarius paradoxus*, *Russula pectinata*, *Hypholoma fasciculare* and *Boletus brevipes* appeared in abundance. Others seen rarely were: *Laccaria laccata*, *Tricholoma melaleucum*, *Lactarius hygrophoroides*, *L. pergamenus*,

*Flammula flavidella, Entoloma subcommune, E. floridanum, Agaricus pocillator* and a new species of *Tricholoma.*

Dec. 25.—Clear and mild; a good shower at twilight; then clearing and much colder. *Gomphidius alachuanus* and *Scleroderma geaster* appeared in quantity. On a lawn under a large loblolly pine fully 200 hymenophores of *Lactarius paradoxus* were seen. Other fungi observed were: *Amanita cothurnata, Pleurotus geogenius,* a large brown Cortinarius, *Clathrus columnatus,* fresh *Pycnoporus sanguineus, Lepista Westii,* and *Amanitopsis vaginata,* yellow form.

Dec. 26–Dec. 27.—Clear, cold, with strong northeast wind. Collected three fine specimens of *Armillaria nardosmia inodora* under a laurel oak, the first ever seen in Gainesville, although it has twice been collected a few miles away. The largest of the three was 10 cm. broad. The flesh was odorless and at first tasteless but soon became distinctly acrid. *A. caligata* is similar but occurs in coniferous woods and always has an agreeable odor and flavor. Fresh oyster mushrooms were seen on a magnolia log.

Dec. 28–Dec. 31.—Some rain but too cold for fleshy fungi. Only *Boletus brevipes* and *Pluteus cervinus* were seen. Temperature dropped to 34° but too windy for frost.

The year 1948 was the second warmest since 1911. November temperature was the highest on record. December temperature averaged 62.7°, 6.4° above normal. Rain for the year was 12 inches above normal, 13 inches falling in March, and establishing a record for the month.

December afforded an excellent test for the influence of habit on fleshy fungi. Conditions seemed ideal but failed to affect well-established species. Like most of the trees and flowers, the fungi went into winter quarters when the usual time came and remained dormant until another season. For most species of fleshy fungi this would mean next summer, from late June to early September.

# Studies in Florida Botany

## I. A Key to Indigenous Florida Palm Genera

Alex D. Hawkes

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The following dichotomous key to the indigenous genera of the Palmae of Florida is given here to facilitate the work of students in this fascinating plant family in our southernmost state. The inclusion of the genus *Cocos* L., with its monotypic species *C. nucifera* L., may be open to some criticism, but inasmuch as this cosmopolitan tree occurs in a spontaneous state within our area, its listing here seems justifiable.

The key has been greatly simplified for the use of students not widely versed in scientific terminology.

I. Leaves pinnate.
  A. Fruit a very large woody structure, to 3 dm. or more long. Trunk somewhat roughened by annular rings, typically curved on maturity. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 2. Cocos
  B. Fruit not a woody structure. Trunk curved or straight on maturity, smooth or roughened.
    1. Fruit bright orange-red, about 15 mm. long and broad. Trunk roughened by annular rings, usually curved on maturity, 4. Pseudophoenix
    2. Fruit dark red or red-brown, 8–13 mm. long and up to 10 mm. broad. Trunk relatively smooth, usually straight on maturity, 6. Roystonea

II. Leaves palmate.
  A. Always trunkless palms. Base of plant covered by fibrous sheaths and long spines. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 5. Rhapidophyllum
  B. Trunked or trunkless palms. Never spiny at base of plant.
    1. Leaf-petioles smooth.
      a. Leaves green, same color above as below. . . . . . . . . . . . 7. Sabal
      b. Leaves green; glaucous-white, silvery or lighter green below.
        (1) Leaves silvery below. . . . . . . . . . . . . . . . . 1. Coccothrinax
        (2) Leaves glaucous-white or lighter green below, 9. Thrinax
    2. Leaf-petioles spiny or partly so.
      a. Clustered palm forming clumps to 14 m. high. Under-surface of leaves silvery. . . . . . . . . . . . . . . . . . . . . . . 3. Paurotis
      b. Solitary or branching palm, usually under 2 m. high, generally prostrate on ground. Under-surface of leaves green or glaucous. . . . . . . . . . . . . . . . . . . . . . . . . . . . 8. Serenoa

1. Coccothrinax Sargent in Bot. Gaz. **27** (1889) 87.
    (1) *C. argentata* L. H. Bailey Gent. Herb. **4**, vi (1939) 223.
2. Cocos Linnaeus Musa Cliff. (1736) 11.
    (2) *C. nucifera* Linnaeus Sp. Pl. (1753) 1188.
3. Paurotis Cook in Mem. Torrey Bot. Club **12** (1902) 21.
    (3) *P. Wrightii* (Griseb. & Wendl.) Britton in Torreya **8** (1908) 239.
4. Pseudophoenix Wendland ex Sargent in Bot. Gaz. **11** (1886) 314.
    (4) *P. Sargentii* Wendland ex Sargent, l. c.

5. RHAPIDOPHYLLUM Wendland & Drude ex Drude in Bot. Zeit. **34** (1876) 803.
   (5) *R. hystrix* (Pursh) Wendland & Drude ex Drude, l. c.
6. ROYSTONEA Cook in Science, ser. 2, **12** (1900) 479.
   (6) *R. regia* (HBK) Cook, l. c., in note.
7. SABAL Adanson Fam. Pl. **2** (1763) 495.
   (7) *S. etonia* Swingle ex Nash in Bull. Torr. Club **23** (1896) 99.
   (8) *S. minor* (Jacq.) Persoon Syn. Pl. **1** (1805) 399.
   (9) *S. Palmetto* (Walter) Loddiges ex Schultes & Schultes Syst. Veg. **7**, ii (1830) 1487.
8. SERENOA Hooker fil. ex Benth. & Hook. Gen. Pl. **3**, ii (1883) 926.
   (10) *S. repens* (Bartram) Small in Journ. N. Y. Bot. Gard. **27** (1926) 197.
9. THRINAX Linnaeus fil. Gen., ed. Schreb. (1791) 772.
   (11) *T. microcarpa* Sargent in Garden & Forest **9** (1896) 162.
   (12) *T. parviflora* Swartz Fl. Ind. Occ. **1** (1797) 614.

# The Typification of the Genus Goniophlebium Presl

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The generic name *Goniophlebium* was taken by Presl from a sectional name given by Blume (*Polypodia spuria* sect. *Goniophlebium* in Fl. Javae 2, 1830, p. 132). But Presl had not seen specimens of the species upon which Blume based his section (at that time, only the brief sectional diagnosis had been published; the detailed descriptions of the species and the plates were issued much later). Presl published a new description (Tent. Pterid. 1836, p. 185) for his genus, and at the end he wrote "species Blumeanas non vidi et solummodo ex auctoritate clar. Blume huc retuli." In citing the species belonging to the genus, Presl listed first some tropical American species clearly referable to the genus, and then the Asiatic species upon which Blume had based his section. Presl was in doubt about the generic identity of these species, as is evident from the query accompanying the generic initial (*G? cuspidatum* Bl., etc.).

According to some authors (including Copeland in Univ. Calif. Publ. Bot. 16, 1929, p. 109), Blume's species constitute a genus distinct from that containing the other species described by Presl. But to which of these groups should the name *Goniophlebium* be applied?

Copeland (Gen. Fil. 1947, p. 181) stated that Presl took the name from Blume "and could not do this without taking also whatever type of Blume properly went with the name." But Presl in another case used a sectional name (quoted by him) for a genus without removing the type of the section. In establishing this genus (*Anapausia* Presl, Epim. Bot., p. 185), Presl expressly excluded all species originally placed by him under that sectional name (*Gymnopteris* 2. *Anapausia* Presl, Tent. Pterid., p. 224). Copeland accepted this exclusion (Gen. Fil. 1947, p. 132).

The cases are not exactly parallel. Presl expressly excluded species referred to his former section from the genus *Anapausia;* in fact, he founded a new genus, for which he should have used a different name. In the case of *Goniophlebium* Presl adopted Blume's name and prepared a new description for it, based on species seen and figured by him. But he had his doubts regarding Blume's species, though he included them in his new genus.

In both instances, Presl actually established new genera, adopting names previously used for sections. He was not obliged to use either of these names for reasons of priority. In fact, he was free to adopt these old sectional names in a new sense for genera, and used this privilege, in one case by expressly excluding from the genus all species previously referred to the section under that name, and in the other case by tentatively referring all species under the section to the genus. But a genus cannot be typified by a species tentatively referred to it. Consequently, *Goniophlebium* should be typified by one of the American species studied and described by Presl in establishing this genus and not by Asiatic species which he never saw and included only tentatively.